STEAM4Climate Teacher's Guide to Project-Based Climate Education

From measurements to meaning – studying ecosystems

Students worksheets

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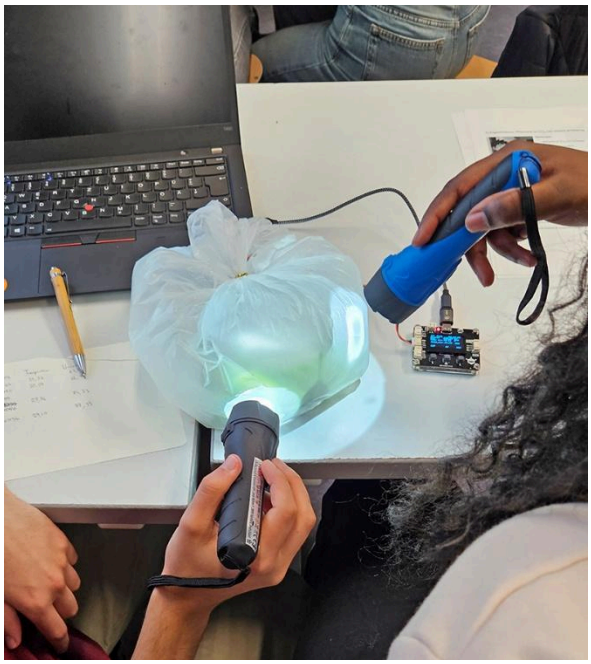
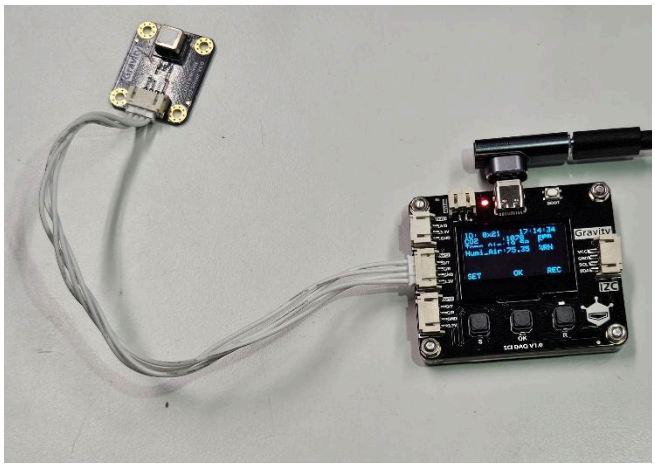
Introduction



This collection of worksheets provides hands-on experiments that help students explore how carbon dioxide and oxygen behave in everyday environments. Using the SCI DAQ system and dedicated sensors, learners investigate real-world processes such as air quality, respiration, combustion, the greenhouse effect, and photosynthesis.

Each experiment includes clear instructions, observation tasks, and reflection questions to support guided inquiry.

The materials are designed to help both teachers and students quickly understand the purpose of each activity, link measurements to environmental concepts, and build a deeper understanding of how CO_2 influences our climate and ecosystems.



Materials:

All experiments are conducted by students using the SCI DAQ from DfRobot.
https://www.dfrobot.com/product-2655.html

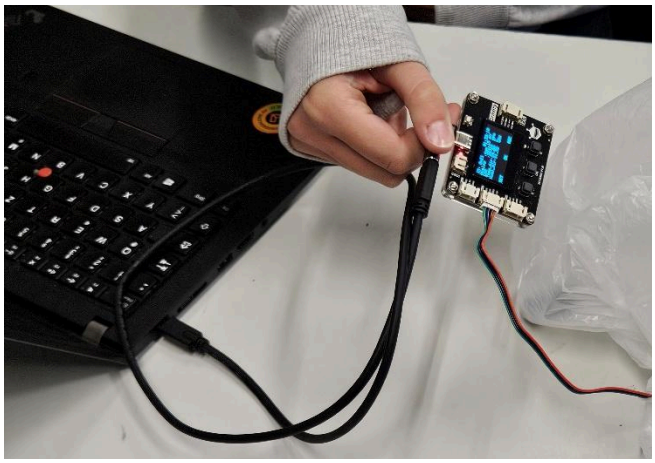
The following sensors are used:

a) the SCD41 sensor for CO2 measurements:

https://www.dfrobot.com/product-2646.html

b) the ‘Electrochemical O2 Sensor’ for oxygen measurements:

https://www.dfrobot.com/product-2052.html



The SCI DAQ is connected to a computer to supply it with power and, if necessary, to transfer the measured values.

Fresh spinach leaves are also required for the oxygen measurements:

Experiment 1: Measuring CO_2 in our environment

Material:

- CO_2 sensor with display
- Timer / stopwatch

Task: We measure the CO_2 values in three situations:

1. In the classroom (windows closed)
2. With the window open / outside
3. When we exhale directly to the sensor

Guide:

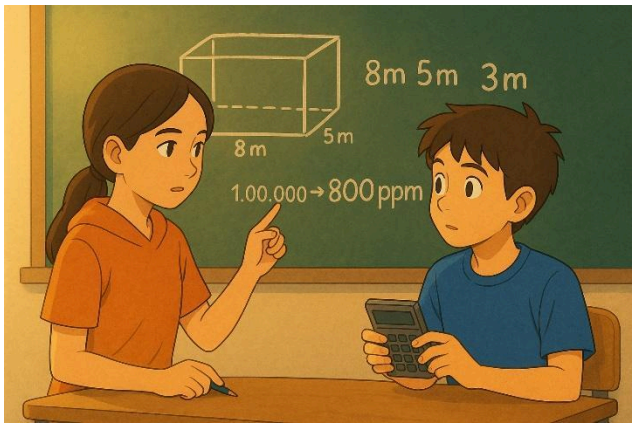
1. Turn on the sensor and wait a short time until the value is stable.
2. Start measuring in the classroom and write down the value.
3. Open windows or go outside, write down new value.
4. Blow slowly on the sensor, note the value.

Observe: How much do the ppm values change?

Evaluation: → Write your answers in the lines below.

1. Which measurement situation had the highest CO_2 content and why?
2. Why is fresh air important for our health and the climate?

Experiment 2: What does "ppm" mean?



Material:

Calculator - Blackboard / Booklet

Task:

We think about how much CO_2 there is in our classroom.

Guide:

1. We calculate the volume of the room (length × width × height).
2. We use a typical CO_2 value in the room (e.g. 800–1000 ppm).
3. We calculate how many liters of CO_2 that is.

Note: ppm means "parts per million".

Evaluation: → Write your answers in the lines below.

1. Why is CO_2 important for the climate even at low ppm values?
2. Why can a small amount per million still have a big impact?

Experiment 3: Breathing air in a plastic bag

Material:

-Plastic bag

- Straw / Tube

- CO_2 sensor

Guide:

1. Open the bag and place the sensor inside.
2. Measure once: How much CO_2 is in the bag in normal air?
3. Exhale through the tube into the bag.
4. Measure again.

Observe: How much does the CO_2 value increase with exhalation?

Evaluation: → Write your answers in the lines below.

1. Why is CO_2 from respiration not the main problem in climate change?
2. What is the difference between "biological" CO_2 and fossil CO_2?

Experiment 4: Combustion produces CO_2

Material:

- Standing cylinder or large glass

-Match

- CO_2 sensor

Guide:

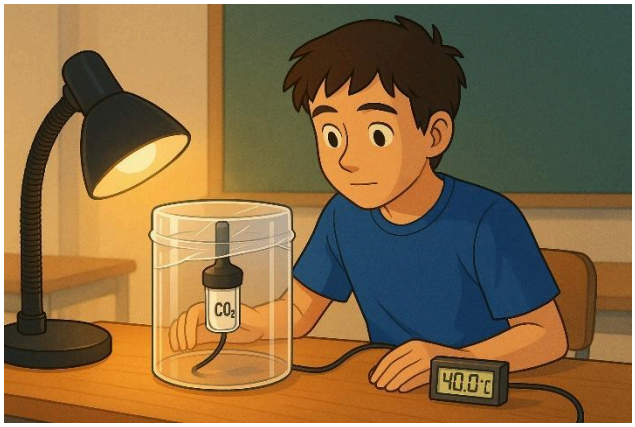
1. Hold the CO_2 sensor briefly in the cylinder and note the value.
2. Remove the sensor.
3. Light the match and drop it into the cylinder.
4. When the flame goes out, hold the sensor back in.
5. Compare value.

Observe: After combustion, more CO_2 is present.

Evaluation: → Write your answers in the lines below.

1. Why is CO_2 produced during combustion?
2. What does this experiment have to do with industry and energy production?

Experiment 5: CO_2 chamber (greenhouse effect)



Material:

- Tube (approx. 15 cm diameter)
-Cling film
- CO_2 sensor
- Lamp (bulb approx. 60 W)
- Sodastream CO_2 if necessary

Guide:

1. Close the tube with foil at the front and back.
2. Place the sensor inside.
3. Illuminate with a lamp from the outside.
4. Wait for the temperature to remain stable.
5. Introduce CO_2 and continue to measure it.

Observe: With more CO_2, the temperature rises more.

Evaluation: → Write your answers in the lines below.

1. Why does CO_2 act like a "thermal blanket"?
2. What does this mean for global warming?

Experiment 6: CO_2 degradation by plants

Material:

- Same tube as in the previous attempt
- Fresh spinach leaves or other green leaves
- CO_2 sensor
-Lamp

Guide:

1. Insert the sensor and measure the starting value.
2. Place leaves in it.
3. Turn on the lamp.
4. Wait 10-15 minutes and observe.

Observe: The plant breaks down CO_2 (photosynthesis).

Evaluation: → Write your answers in the lines below.

1. Why do plants act as CO_2 sinks?
2. How do forests and green spaces help with climate protection?