

Carbon dioxide measurements in the classroom

Simple experiments and demonstrations where a carbon dioxide analyser is used



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Carbon dioxide measurements in the classroom

Biology, ecology and environmental education contains many theoretical concepts and models. Students often need help to understand both the simple and more complex interactions. Simple experiments and demonstrations can provide a better understanding and encourage students to ask their own questions, which contributes to pupils' learning knowledge.

By measuring the carbon dioxide content, several basic biological concepts and environmental issues can be visualized in a simple and tangible way.

Examples of some basic approaches that can be demonstrated by experiments with a CO₂ meter:

Photosynthesis, respiration, compensation point, carbon source, carbon trap, soil respiration, decomposition, circulation and stomata.

Other issues can be examined:

How is the photosynthesis affected by the light intensity, temperature, or plant material?

How is the respiration affected by water content, temperature or substrate?

The experiments are suitable to perform as demonstration experiments. In-depth experiments and extended experiments can be done as student laboratory work or project work.

Photosynthesis and respiration experiments

Measurements in a jar

Material:

Carbon dioxide meter with a pump, for example EGM4 pp-Systems

Glass jar with tight-fitting lid and mounted connectors

Hoses

Nipples

Computer

Good natural light or lamp

A dark cloth

Plant material, spruce twigs, birch twigs, small flower pots

In-depth experiments:

Luxmeter, thermometer, light chamber

Methods:

- Place a spruce twig into the jar.
- Place the jar in the classroom.
- Let the students formulate a hypothesis about how carbon dioxide concentration will change during the test in the classroom
- Set the meter to auto logging 1 every minute. Alternatively you can log readings every 10 seconds by the computer.
- Turn on the meter and start measuring.
- The CO₂ concentration is recorded continuously and can be followed continuously on the computer screen.
- Is the students' hypothesis in accordance with the result of the test?
- Vary the light intensity by either moving out into the daylight or increasing lighting
- Cover the jar with a dark cloth.
- Discuss and analyze the different phases of the CO₂ curve.



Figure 1. Measurement of photosynthesis and respiration in a spruce twig in low light; the carbon dioxide concentration increases.

Examples of issues that can be discussed in connection with the experiment.

- Why does the CO₂ concentration increase?
- Why does the CO₂ concentration decrease?
- From where does the carbon dioxide come?
- What happens if the CO₂ concentration is constant?
- What factors might affect how fast the CO₂ concentration changes?
- How does the CO₂ concentration vary in a natural ecosystem during a 24-hour period/during a year?
- How does vegetation influence the CO₂ concentration in a global context?
- Why is there a condensation in the jar when it is moved from low light intensity to bright light?



Figure 2. Indoor Measurements of photosynthesis and respiration in a spruce twig



Figure 3. Outdoor Measurements of photosynthesis and respiration

Phase 1 Indoor in low light Phase 2 Outdoor Phase 3 Darkened glass jar

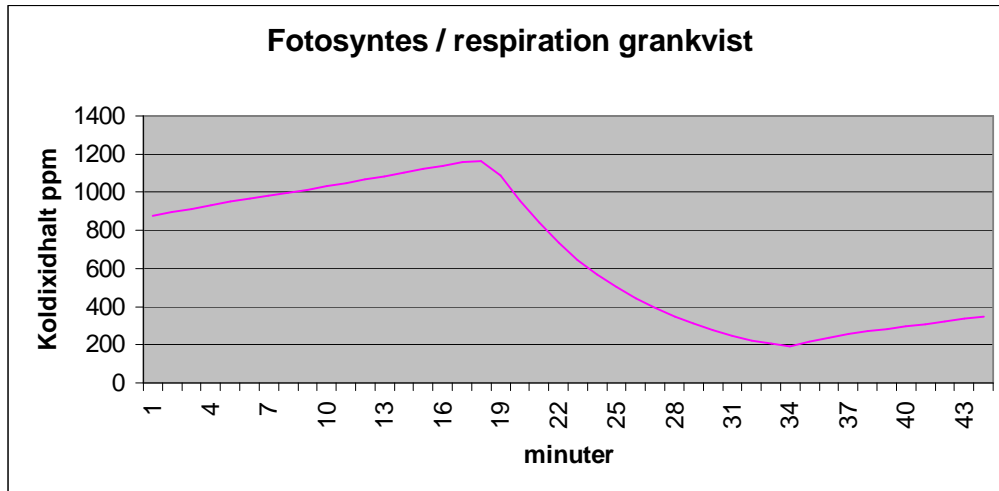


Photo 4 Example of results.

In-depth experiments

Let the students themselves formulate a question and then work out a proposal of an experimental method to be discussed with the teacher before it is performed.

Suggested questions and experiments:

- Determine the compensation point for different plants, compare plants adapted to low light with light-demanding species.
- Determine the photosynthesis per area unit. Make area calculations on needles or leaves.
- Follow the CO₂ concentration over several days or even longer. A potted plant or a plant set in the soil at the bottom of a jar can be used here. Compare with a jar containing only soil without a plant.

Soil Respiration Experiments

Measurements with a soil cuvette

Material:

Carbon dioxide meter with a pump, for example EGM4 pp-Systems

A soil cuvette (Eg sewer Ø 10 x 20 cm, with a tightly fitting lid and mounted connectors)

Hoses

Nipples

Computer

Plastic Boxes

Soil Samples: For example, sandy soil, peat soil, compost soil, podsol, garden soil, soil that is stored in a refrigerator

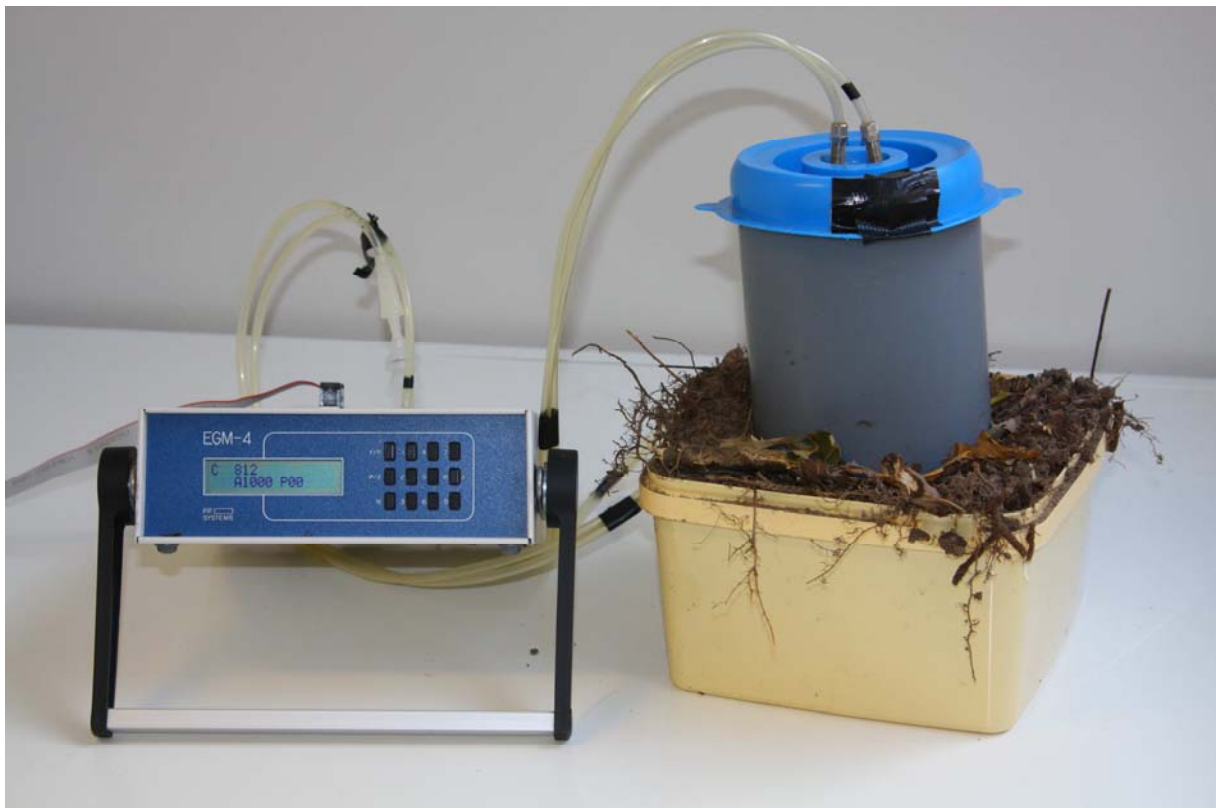


Figure 5. Measurement of soil respiration with a soil cuvette

Methods:

- Different types of soil placed in plastic boxes.
- A soil cuvette placed in the soil sample. The tube should be pressed down 1-2 cm into the soil.
- Set the meter for automatic recording.
- Connect the instrument

- The CO₂ concentration can be monitored continuously on the computer screen. When the system is stabilized and the curve shows a steady climb manual measurements are made every 10 seconds during 1 minute.
- The slope is proportional to the size of soil respiration per unit area.
- Repeat the experiment on a few different types of soil.
- Transfer the measurements to the computer.
- Make charts and graphs of measurement results using Excel.
- Analyze and discuss the results.

Comments on the experiment

The experiment requires some computer experience which the pupils may not have. One suggestion is to analyze the soil together in class and then use prepared test results that can be evaluated and discussed.

It might be enough to compare two soils and see that the slope of the curve is different in different soils.

Examples of issues to be discussed in connection with the experiment.

Why was the respiration different in the various experiments?

What factors can affect the size of the soil respiration?

What processes in the soil can produce carbon dioxide?

What effect might drainage of marshes have on carbon balance?

How is the global CO₂ concentration affected if large areas of permafrost thaw due to hotter climate?

