

## B2 Inclusion: Greenhouse effect in a drinking cup

This experiment can be used to teach students to readily describe and distinguish the physical phenomena underlying the greenhouse effect, such as radiation, reflection, absorption, and heat radiation. The students must have some prior knowledge to be able to analyze the results of the experiments. For this reason, the experiment can be used as verification of material learned after an introduction of the mentioned topics. To that end, the students should also ask questions about the content, answer them using their observations from the subexperiments, and thus delve deeper into the content.

### 1 Main question

Climate change caused by the greenhouse effect is the subject of national political discussions as well as of international conferences and agreements (see the context orientation at the beginning of the student instructions). The scientific questions are: How is the heating effect produced in the drinking cup (greenhouse)? To what extent can this be transferred to the Earth's atmosphere?

#### **Subexperiment 1:**

Measuring the temperature in an open cup

#### **Subexperiment 2:**

Measuring the temperature in a closed cup

#### **Subexperiment 3:**

Measuring the temperature in a closed cup with black paper

#### **Subexperiment 4:**

Measuring the temperature in a closed cup with white paper or aluminum foil

#### **Subexperiment 5:**

Measuring the temperature in a closed cup filled with carbon dioxide



Fig. 1: A simple model of a greenhouse

### 2 Integrating the experiment into the teaching context

#### 2.1 Basic principles

The students should have prior knowledge of the terms conservation of energy, radiation, reflection and absorption of radiation, and of the three forms of heat transfer (heat conduction, heat convection, and heat radiation). A differentiated approach to the experiments is necessary to clarify the phenomena.

If some of the students do not have this prior knowledge, teachers can of course use the experiment as an introduction to these topics.

## 2.2 Relevance to the curriculum

Areas of expertise in selected curricula from Saxony-Anhalt

Biology in grade 5/6:

### **Investigating living organisms' habitats and changes in them**

- Recognizing and explaining human-induced changes in the sources of life

Chemistry in grade 9/10:

### **Comparing carbon and silicon as significant substances**

- Researching the media for the causes and consequences of the greenhouse effect
- Characterizing carbon dioxide as a causal agent of the greenhouse effect
- Debating correctly and logically about the carbon dioxide cycle and the greenhouse effect
- Evaluating statements about the greenhouse effect

Physics in grade 7/8:

### **Explaining thermal effects and balancing heat exchange processes**

- Transferring physical processes in a greenhouse to processes in the atmosphere

The students will ...

- work out the theory behind the principles of the greenhouse effect.
- investigate the influence of different experiment setups on temperature.
- conduct and analyze the experiments independently.
- answer the "research question."

## 2.3 Experimental variations

- The students should conduct all experiments by groups and then present the results to the class.
- The hints provide clues both for experimentation and for answering the questions.
- Teachers can decide which level of tasks to use with the students.

## 3 Additional information on the experiment

You will find additional media for preparing or for further study of this experiment on the Media Portal of Siemens Stiftung: <https://medienportal.siemens-stiftung.org>  
(see Experimento | 10+: B2 Greenhouse effect in a drinking cup (teacher instructions).)