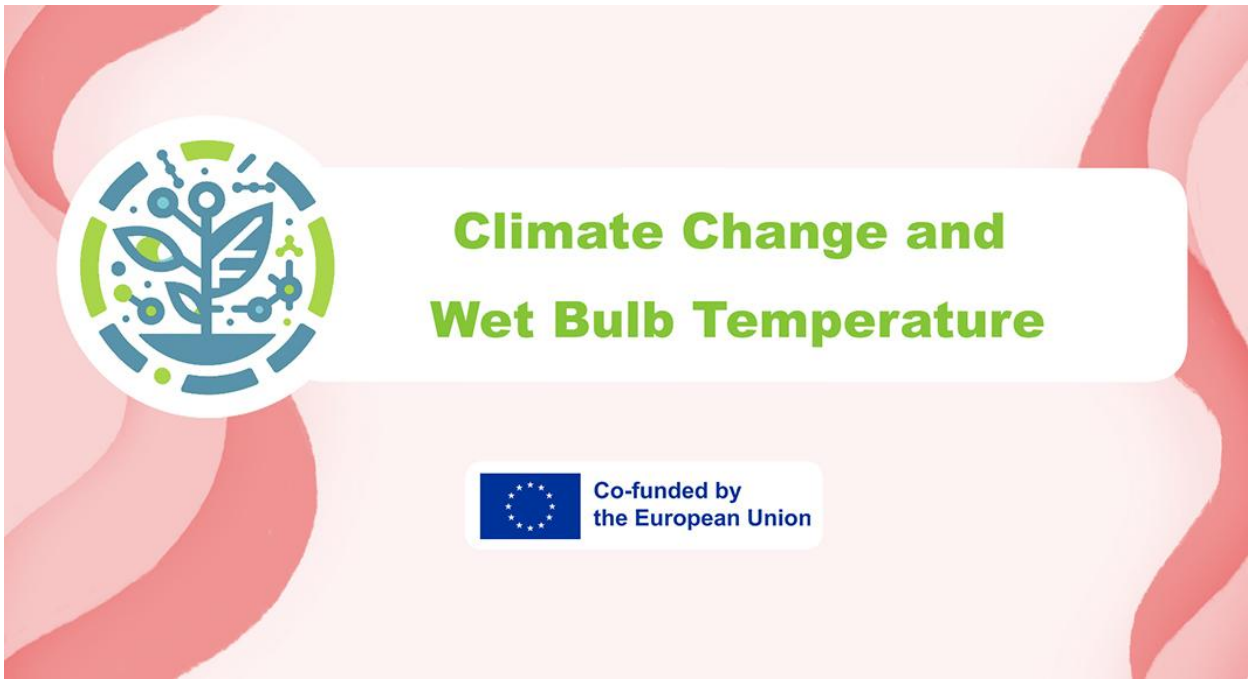

STEAM4Climate Worksheet

for students

Project: Climate Change and Wet Bulb Temperature

Extension:

CO2 Chamber to illustrate the greenhouse effect

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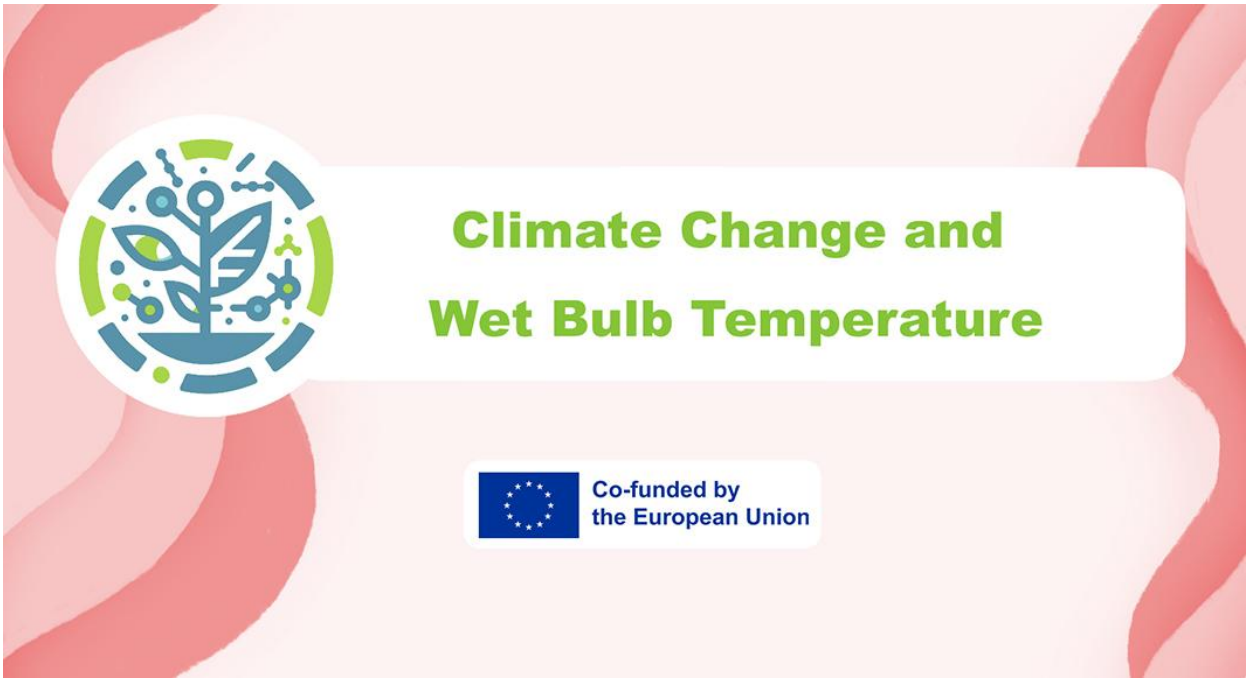

EU Project Consortium

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Disclaimer

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About This Booklet

Welcome to the STEAM4Climate Student Activity Worksheet on Climate Change and Wet Bulb Temperature, an educational resource designed to complement the STEAM4Climate Teacher's Guide Booklet one. Developed as part of the Erasmus+ STEAM4Climate project, the booklet introduces the concept of wet bulb temperature, its effect on the human body, and its relevance in our warming climate. Students will conduct hands-on experiments to explore how heat and humidity impact thermoregulation. To explore the full collection of student worksheets and related teacher guides, visit 🔗 Steam4climate Website

It is designed to guide you through hands-on activities and experiments that explore the impacts of extreme heat and humidity. It includes step-by-step instructions, discussion prompts, and real-world case studies to help deepen your understanding of climate-related challenges.

- ◇ Work through the activities in order to build on key concepts.
- ◇ Record your observations and reflections in a notepad.
- ◇ Engage in group discussions to explore solutions and share ideas.
- ◇ Use the additional exploration prompts to expand your learning beyond the classroom.

By actively participating in these activities, you will develop problem-solving skills, scientific thinking, and an awareness of how climate change affects human health and the environment. Get ready to experiment, explore, and innovate!

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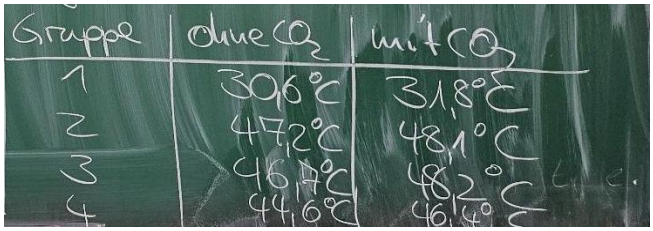
Experiment CO_2 and the Greenhouse Effect



Top: full setup of the experiment
Left: in-class setting
Right: some outcome of different groups

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Materials List

- 1 **desk lamp** with a 60-watt incandescent bulb (preferably with a flexible neck)
- 1 **rectangular plastic container** (approx. 1.5 liters volume, search google for "*short radius bend drainpipe 15 degree*"
- **Plastic wrap/cling film** (for sealing the container as airtight as possible)
- **2 rubber bands** (to secure the plastic wrap to the container)
- **1 digital thermometer with external probe**, measuring at least up to 50 °C (https://www.amazon.de/dp/B07TY6HRL4/?coliid=I1CBS8Z1MAEHQK&colid=1BWI33O8U8BR4&ref_=list_c_wl_lv_ov_lig_dp_it&th=1)
- **1 CO_2 inflator** (e.g., for bicycle tires) with CO_2 cartridge and a extension tube
  Alternatively: Dry ice (with supervision, for advanced groups)
- **Stopwatch or clock** (e.g., phone)

CO2-inflator for easy handling.

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Setup Instructions

1. **Prepare the container:**
    - Place the probe of the digital thermometer in the center of the container's interior.
    - Fill the container with ambient air (simply leave it open for a moment).

2. **Seal the container:**
    - Cover the container tightly with plastic wrap and fix it with two rubber bands around the edge to make it as airtight as possible.

3. **Position the lamp:**
    - Place the desk lamp approx. 5–10 cm away from the side of the container, so the light shines directly onto the container wall.
    - Ensure that the thermometer display is visible outside the container.

4. **Prepare the CO_2:**
    - Get the CO_2 inflator with cartridge ready, but do not use it yet.

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Procedure

1. **Phase 1 – Heating with Ambient Air:**
    - Turn on the lamp.
    - Read and document the temperature inside the container every 2–3 minutes.
    - Wait until the temperature inside the container reaches a stable maximum (no further increase for 5–10 minutes).

      → This usually takes about 5–10 minutes.

2. **Phase 2 – Replace Air with CO_2:**
    - Remove one rubber band from a corner, gently lift the plastic wrap.
    - Hold the CO_2 inflator at the opening and let CO_2 flow in for a few seconds (try to avoid letting in additional ambient air).
    - The probe stays inside the container!
    - Quickly reseal the container to be airtight.

3. **Phase 3 – Heating with CO_2:**
    - Turn the lamp back on
    - The temperature inside the container will usually drop slightly at first (the CO_2 is cooler than the previous air).
    - As before, document the temperature every 2–3 minutes.
    - Wait again until a stable maximum temperature is reached (about 15–25 minutes).

4. **Phase 4 – Temperature Comparison:**
    - Compare and document both maximum values (with ambient air and with CO_2).

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Expected Observations

- **With ambient air:**
  The interior heats up due to the lamp and reaches a stable value after about 5-10 minutes (usually around 35–40 °C, depending on room temperature and setup).

- **After adding CO_2:**
  The temperature inside the container initially drops slightly (the CO_2 is cooler).

- **With CO_2:**
  After turning the lamp back on, the temperature rises again – but this time significantly more! The new maximum is typically **2–4 °C** higher than with ambient air.

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Conclusion and Learning Objective

What should students learn from this?

- **CO_2 is a greenhouse gas:**
  The experiment vividly demonstrates that a higher concentration of CO_2 in the air causes a closed space (or the atmosphere) to heat up more under light exposure.

- **Principle of the greenhouse effect:**
  CO_2 allows visible light to pass through but absorbs the infrared (heat) radiation emitted by warmed surfaces. This traps more heat inside the container.

- **Relevance to climate change:**
  The experiment provides a simple model for both the natural and the human-enhanced greenhouse effect, as it occurs on Earth with rising CO_2 concentrations.

Note for teachers:

For a meaningful comparison, perform the experiment at least twice (once with ambient air, once with CO_2). Carefully document temperature values and discuss the causes and effects together with the class.

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Worksheet: CO_2 and the Greenhouse Effect

1. Observations

a) What was the maximum temperature inside the container with normal air?
Answer: _____

b) What was the highest temperature inside the container with CO_2?
Answer: _____

c) By how many degrees did the temperature increase after adding CO_2?
Answer: _____

2. Understanding the Experiment

a) Why did we cover the container with plastic wrap during the experiment?
Answer: _____

b) Why did the temperature drop right after the CO_2 was added?
Answer: _____

c) Why did the temperature rise higher with CO_2?
Answer: _____

3. Drawing Conclusions

a) What does this experiment show about the effect of CO_2?
Answer: _____

b) How is this experiment similar to what happens in Earth’s atmosphere?
Answer: _____

c) In your own words, explain why CO_2 is called a greenhouse gas.
Answer: _____

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