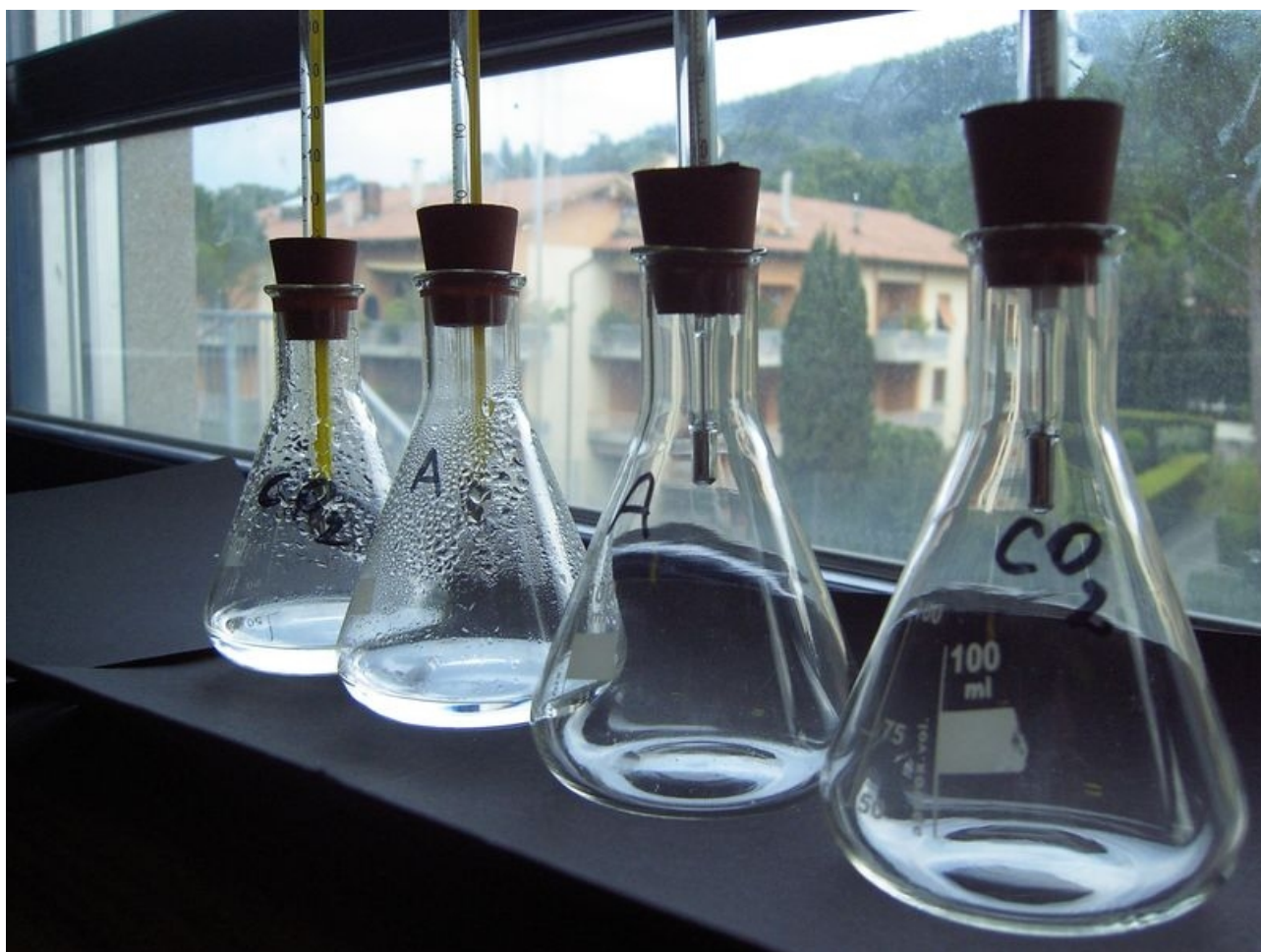


GREENHOUSE EFFECT *IN VITRO!*

Liceo Scientifico N. Copernico, Prato



GOALS:

To demonstrate that CO_2 absorbs thermal radiation and is responsible for atmospheric warming.

TARGET: students of age 14+.

TIME REQUIRED: 4 hours : 2 hours to prepare the flasks, 2 hours to take the measurements and to make observations and discuss the results.

(Note: the measurements can be taken some days after the preparation, if the flasks are hermetically sealed.)

EXPERIMENT:

You can reproduce the greenhouse effect *in vitro* with two different procedures.

- **FIRST PROCEDURE:** You need sodium bicarbonate (NaHCO_3) and hydrochloric acid (HCl) to produce carbon dioxide (CO_2).
- **SECOND PROCEDURE:** You need water and fizzy tablets.

FIRST TYPE

TOOLS:

- 2 glass flasks
- 2 plugs, with a thermometer through each plug
- 1 glass flask with side tube expansion
- sodium bicarbonate (NaHCO_3)
- hydrochloric acid (HCl)
- some black paper

PROCEDURE:

- Introduce sodium bicarbonate inside the glass flask with side tube. Add some HCl (be careful with the acid) and close this flask with a plug. Bring the tube inside one of the two flask. In this way, carbon dioxide that is produced by the reaction between NaHCO_3 and HCl, is conveyed to the second flask. You can be sure that most of the carbon dioxide stays in the flask and doesn't go out, because it is heavier than air. After about 1 minute, close this flask with one of the two plugs with thermometers. Write on the flask: " CO_2 "
- Take the other glass flask and close it with the second plug + thermometer. This flask is your control. Write on it: "air" or "control".

- Put the flasks at the same distance from a light source (for example in front of a window), placing them on black paper. Black paper absorbs visible radiation and emits thermal radiation simulating the Earth's surface.
- Measure the temperature inside each flask at the beginning of the experiment and after some time (at least two to three hours of light).

SECOND TYPE:

TOOLS:

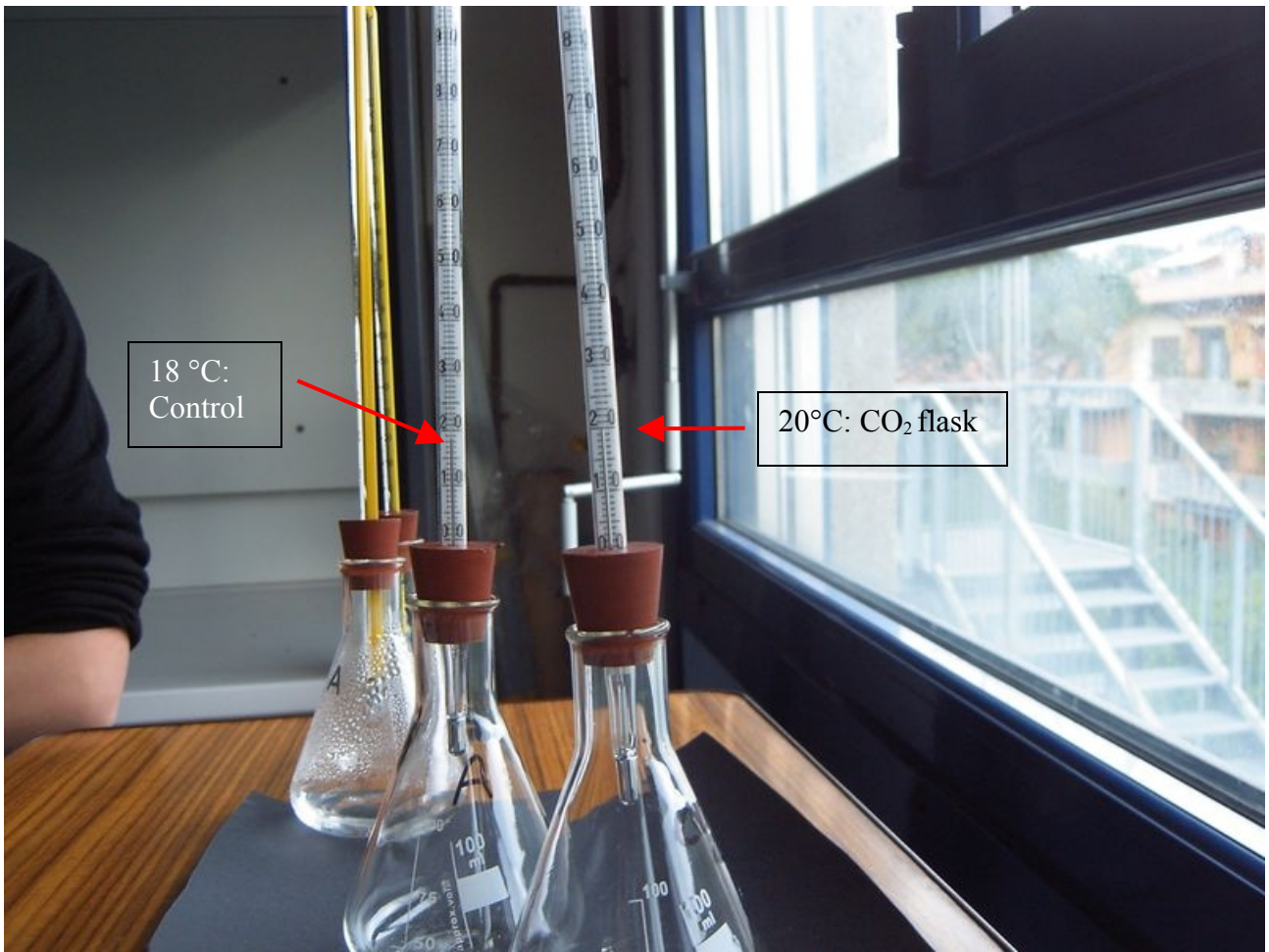
- 2 glass flasks
- 2 plugs, with a thermometer through each plug
- water
- fizzy tablet

PROCEDURE:

- Introduce water in both flasks. One of them is your control. add 1 or 2 fizzy tablets to the other one. As it dissolves in water, the tablet produces carbon dioxide. This is an endothermic reaction, so it leads to a decrease in temperature of the system. Wait for the end of the reaction (no more gas production) and then plug both the flasks.
- Put the flasks at the same distance from a light source (for example in front of a window), placing them on black paper. Black paper absorbs visible radiation and emits thermal radiation simulating the Earth's surface.
- Measure the temperature inside each flask at the beginning of the experiment and after some time (at least two to three hours of light). Usually the start temperature is lower inside the flask with CO₂ because of the endothermic reaction: it is important to evaluate the increase in temperature and not the absolute values.

RESULTS: After three/four hours of light exposition, in both flasks you can see an increase in temperature. The increase is more consistent inside the CO₂ flask, than in the control: the difference is about 2°C.

In the "second procedure" experiment, this difference is less pronounced: 1°C or less; probably because of the presence of water that absorbs part of the thermal radiation.



Developed for CarboSchools by Maddalena Macario and Francesca Bini, Liceo Scientifico N. Copernico, Prato, Italy.
Mail: <mailto:makarios1@libero.it>
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