



## HOW TO PRODUCE CO<sub>2</sub> AND TO TEST SOME OF ITS PROPERTIES

These experiments are easy to carry out and are suitable for every grade of school, from primary to secondary schools.

### Aims

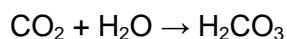
- To investigate CO<sub>2</sub> mass.
- To generate carbon dioxide and test some of its properties.

### Introduction

At standard temperature and pressure, CO<sub>2</sub> is a molecule in gaseous form. It is an important gas existing in the Earth's atmosphere and its concentration is about 0.038%. This gas is important for plants since they use it for the photosynthesis. It is also released during the organisms' respiration, as well as a result of combustion, volcanoes emissions, geothermal hotsprings etc. CO<sub>2</sub> is soluble and oceans and water in general are considered to be a carbon sink.

#### *Characteristics of CO<sub>2</sub> gas:*

- It is solid at -78°C and it sublimates directly without a liquid phase.
- It dissolves in water, where it is an acidic oxide due to the unstable reaction:



- It is an odorless, colorless, non-flammable gas with a molar mass of 44.010 g/mol.
- It absorbs infrared radiation, contributing to the greenhouse effect.

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**Preparation time:** 10 minutes

**Duration of activity:** 5 minutes

**Application:** chemistry

**Time for data analysis and discussion:** 10 minutes

**Previous knowledge required:** none

**Cost:** a few Euros for balloons and other equipments.

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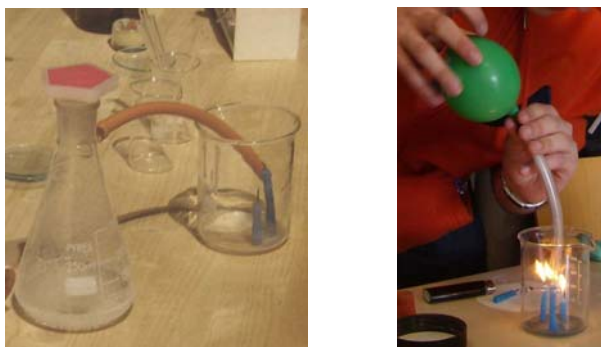
## Experiment 1

### Materials

- 1 beaker (with two openings)
- 1 pot
- 3 candles of different heights
- Water & sparkling powder for water
- 1 plastic tube of 30 cm length

### Procedure

- 1) Fix the three candles in the open pot. Light the candles;
- 2) Put the tube on the side opening of the beaker;
- 3) To generate  $\text{CO}_2$ , mix the reagents in the beaker;  
*vinegar with a little  $\text{NaHCO}_3$ :*  
$$(\text{NaHCO}_3 + \text{CH}_3\text{COOH} \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{NaC}_2\text{H}_3\text{O}_2)$$
  
*or water with sparkling powder*  
*(this reaction will take place:  $\text{HCO}_3^- + \text{H}^+ \rightarrow \text{H}_2\text{O} + \text{CO}_2 \uparrow$ )*
- 4) Immediately, close the beaker and the free end of the tube to keep the gas inside;
- 5) Place the free end of the tube at the bottom of the pot to release the gas.



*Students in the experimental phase*

### Presentation of Results

The gas released by the tube will diffuse in every direction. Due to the fact that the gas is rather heavy and dense, the gas will be denser at the bottom of the pot and the shortest candle will go out. Afterwards, as the gas moves up, the other two candles will go out.

### Note

If no laboratory equipment is available, the reaction can be done directly inside the balloon and then inserted into one of the tube ends

## Experiment 2

### Materials

- 2 balloons
- Water & sparkling powder (Sodium bicarbonate & vinegar)
- 1 beaker
- 1 precision balance
- 1 linear meter

### Procedure:

- 1) Weigh each empty balloon and note the weight;
- 2) Mix the reagents in the beaker (vinegar with  $\text{NaHCO}_3$  or water with sparkling powder) to produce  $\text{CO}_2$ ;
- 3) Quickly insert the empty balloon in the beaker opening and wait till the balloon is inflated, then make a knot in the end to prevent the gas from escaping;
- 4) Inflate the second balloon by blowing into it (don't forget though: your breath also contains carbon dioxide). Make sure that the two balloons have the same diameter;
- 5) Now, weigh both balloons and note the weight.



*Students in the experimental phase*

### Presentation of Results

The precision balance will show the difference in weight of the two balloons testing how big the molar mass is with the high density of  $\text{CO}_2$ . Even if an error in volume of the two inflated balloons is unmistakable, they will show a significant difference in weight.

### Suggested reading (literature or links):

Larcher W. (1993). *Ökologie der Pflanzen*. ©E. Ulmer Verlag – Stuttgart.

<http://it.wikipedia.org/>

<http://mattson.creighton.edu/CO2/>

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