Atmospheric CO_2 can produce ocean acidification

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Introduction

A large amount of the CO_2 that is released into the atmosphere as a result of human activities is absorbed by the oceans (26%). This absorption produces a decrease of ocean pH, with effects on marine life. The efficiency of ocean absorption could also decrease.

Aims

Pupils will observe a seawater acidification by introducing CO_2 directly on seawater or by increasing CO_2 in air above it. They will also observe that CO_2 can pass from seawater to air. Effects on marine organisms can also be observed.

Activity type: experimentation

Prior knowledge required: notion on pH, what is acid, alkaline.

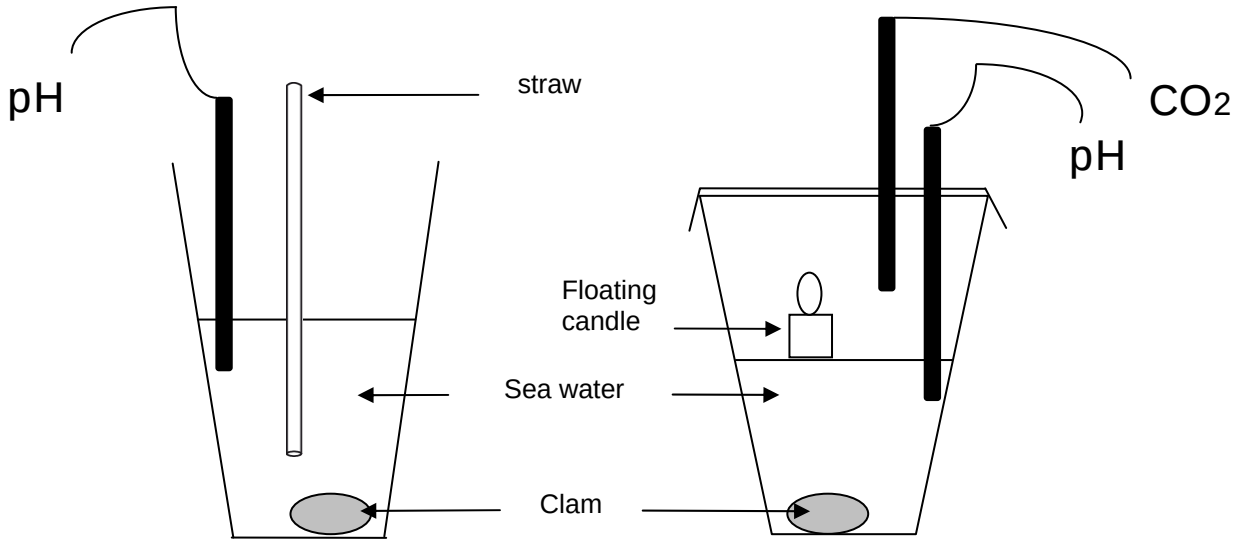
Cost: small if your school has a way to measure pH

Materials

- Containers (at least two)
- Seawater (if you take it form sea costs, you can keep it in a refrigerator for several months)
- pH sensors (you can use also pH indicators)
- floating candles
- straws

Extra-materials for additional parts

- clams
- CO_2 sensors

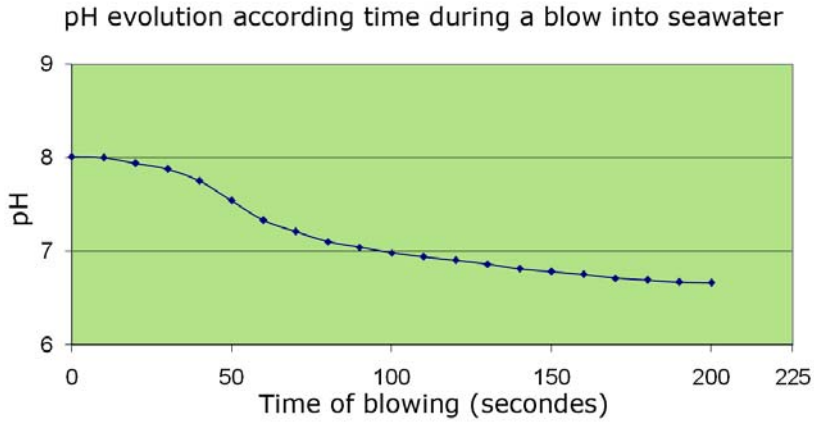


Full material for experimentation (CO_2 sensor and clam are not necessary at first)

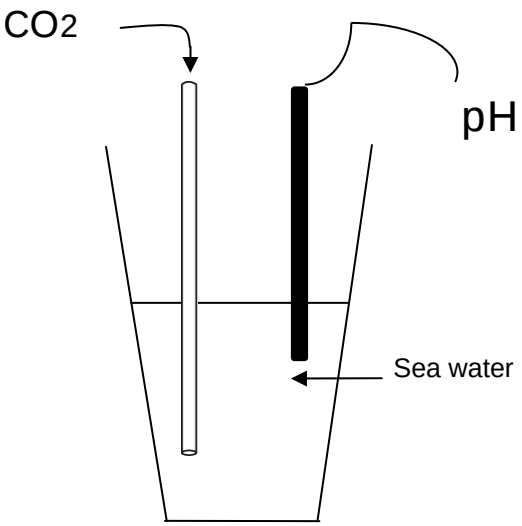
Procedure

Absorption of CO_2 by seawater create acidification

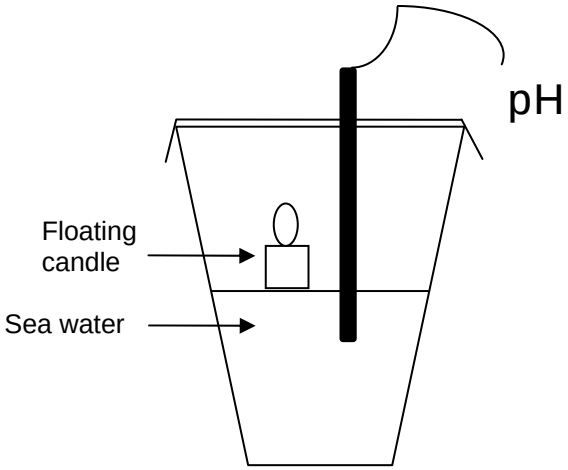
If pupils blow in seawater through a straw, they can observe a decrease of the pH. pH will decrease rapidly and stabilise at around pH 6.5. We can see then the absorption for CO_2 is limited.



Results of a pupils' experiment: they blew directly into seawater by periods of 5 seconds



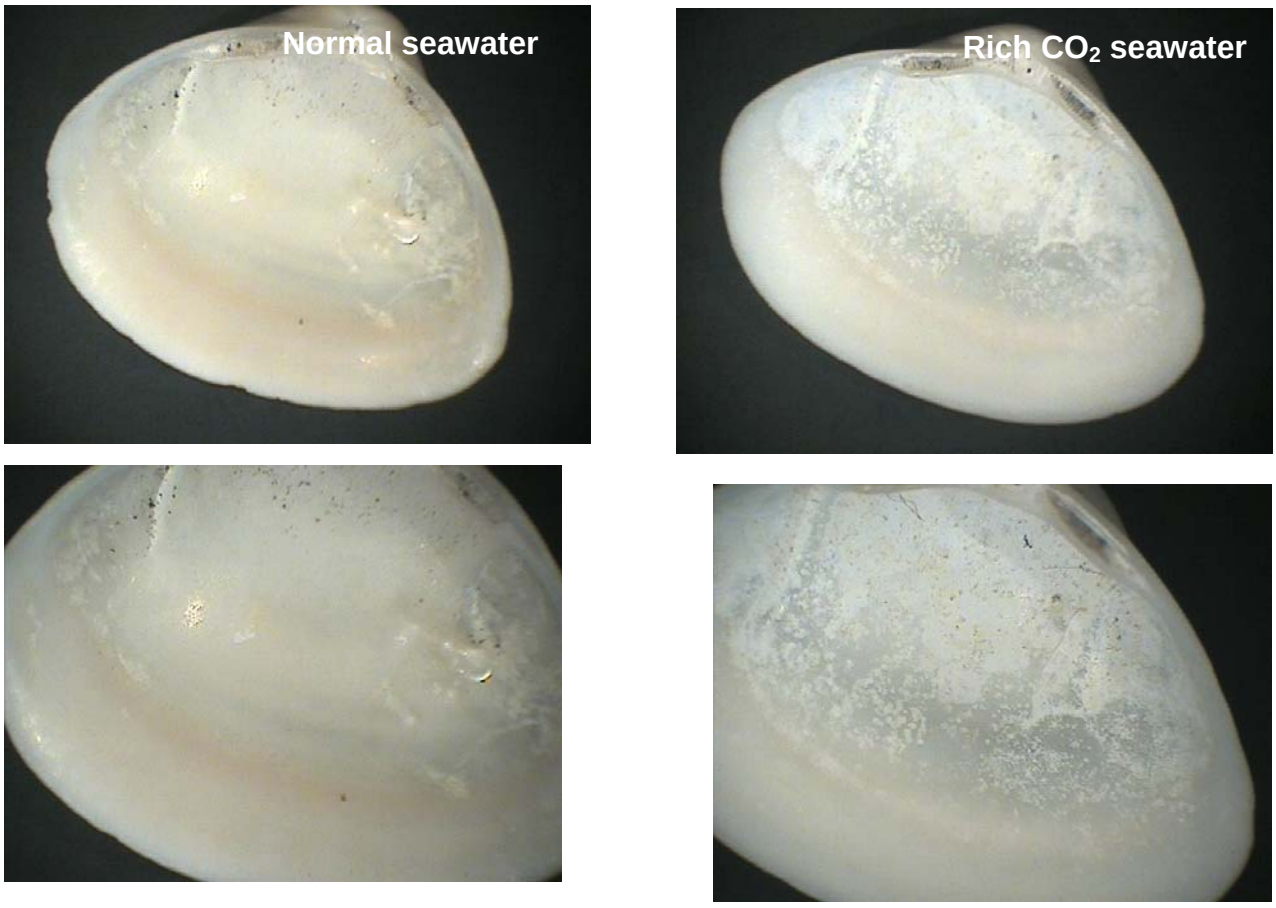
Pupils can say that we will not blow directly in the ocean. So we propose to replace blowing by a floating candle to represent human emissions. The set-up is closed hermetically; the candle switches off after few seconds.
With this set-up we obtain a **shorter and slower decrease of pH** (pH final is around 7 after more than one hour). But this set-up is nearer of the real situation.



It is interesting to test different conditions of water temperature, air CO_2 concentrations and so on. We have to let pupils to imagine different protocols.

Ocean acidification will act on marine life

Ocean acidification will play on calcification shell because the decreasing of pH provokes a decrease of CO_3^{2-}, which is necessary for calcification. With lifeless shells you can see results of a quicker decalcification due to absence of CO_3^{2-}. You have to use very thin shells, as you can find with clams. Do not use living shells, because you will kill them!



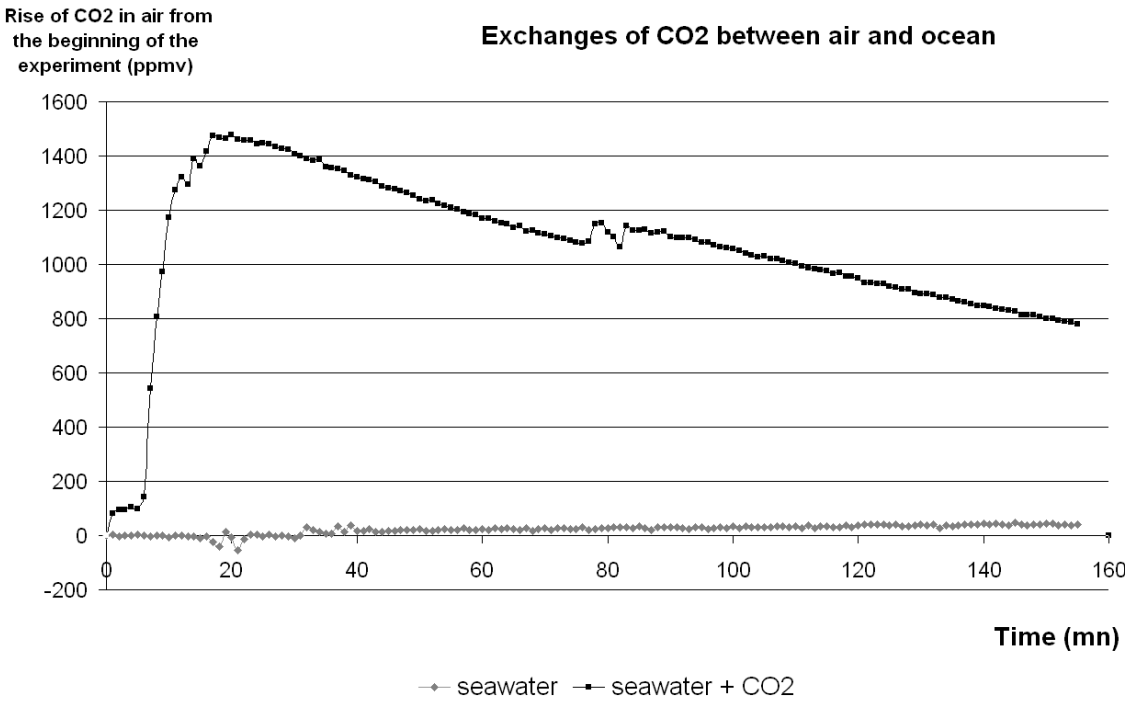
Two clam shells: left in normal sea water, right in seawater where CO_2 was blown into with a straw for 2 minutes every day during 7 days. Right shell lost part of its inside mother-of-pearl.

Some teams maintained also mussel shells in pH 6.5 for a couple of weeks and observed that they became chalky and white in appearance. So you can try with other kinds of shell, but we cannot certify results.
Bellow, you can see differences of weight for different shells tested in condition where pupils blew during 15 days in the air bellow seawater (two minutes per day). We have not the results for the pH but we suppose it was around 6.5. Shells in normal conditions did not change their weight.

Shells		Weight at the beginning (g)	Weight after 15 days (g)
cockle		0,92	0,91
limpet		1,32	1,30
cockle		1,06	1,04
mussel		2,47	2,44

Seawater can also send CO_2 to the atmosphere

If you have an **air CO_2 sensor**, you can also show that CO_2 can go from seawater to the atmosphere. Blow through a draw into seawater for at least one minute. Slowly decant seawater to a new container, add an air CO_2 sensor above the seawater. Close hermetically the recipient, shake the container with measuring air CO_2 concentration; you will see an increase of it, as it is showed bellow.



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