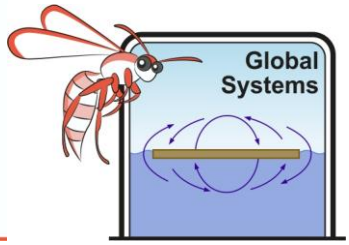


Solution - Teacher Notes

Solution

Solubility of carbon dioxide in cold water

Our oceans absorb 40% of all the carbon dioxide we release. Increased carbon dioxide results in increased ocean acidification (OA)

> ***Ocean acidification, or "OA" for short, is the term given to the chemical changes in the ocean as a result of carbon dioxide emissions.***

Carbon dioxide is soluble in water. Two selected students or teams of selected students may easily demonstrate this by bubbling expired air through water that has been coloured with two drops of Universal Indicator. Green (neutral pH7) water will turn red (acid) in about two minutes indicating that water has become carbonic acid. (Over excitable students can create a colourful wet mess.)

Carbon dioxide + Water → Carbonic acid

$CO_2 + H_2O \rightarrow H_2CO_3$

Carbonic acid dissociates in water to form ions.

$H_2CO_3 \rightarrow H^+$ and $HCO3^-$

Carbon dissolved in sea water is found as a bicarbonate or hydrogen-carbonate ion.

AIM To test the solubility of carbon dioxide in water

Materials

- 2 test tubes half filled with water
- Universal indicator
- 2 straws (plastic are best)

Method

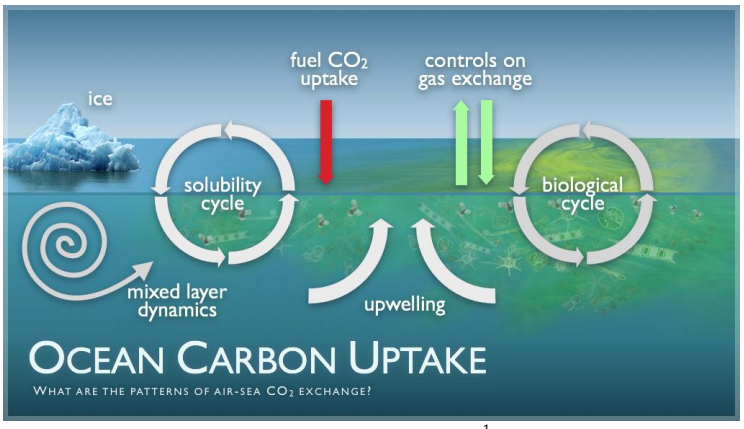
1. Place two drops of Universal Indicator Solution or a strip of indicator paper in each tube
2. Each student blows gently into the test tube. If teams are used each student may blow for 10 seconds before retaining their straw and passing on the test tube to another in their team
3. Blowing stops when a colour change is observed.

Observation

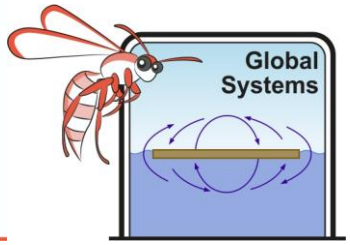
What change occurred? The liquid changed from green to red.

Conclusion

What does this change of colour lead you to conclude? Neutral water (green) became acidic (red) Carbon dioxide is soluble in water.



Produced courtesy of NOAA[1]



Solution - Teacher Notes

The sea is a large sink (reservoir) of carbon dioxide. Carbon dioxide moves between the atmosphere where it is in a mixture with other gasses and the ocean (hydrosphere) until a balance is reached (CO_2 partial pressures are equivalent). An increase in atmospheric CO_2 due to burning fossil fuels or land volcanism will force more into the sea until a balance is reached. The increased concentration moves to mix very slowly as it is driven by slow moving deep ocean currents. Plumes of ocean rich in bicarbonate can be found near industrial areas of the Northern Hemisphere.

Conversely, undersea volcanism outgassing CO_2 or ocean heated because of the enhanced Greenhouse Effect will release CO_2 back into the atmosphere.

The solubility of carbon dioxide in warm water

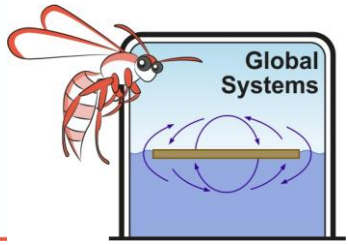
<u>AIM</u> To demonstrate the effect of heat on the solubility of carbon dioxide in water

Materials

- Some carbonated water (cool drink or soda water)
- Two small glasses or beakers
- A hot water bath (larger beaker with a little hot water)

Students may need to be told that the “fizz” in soft drink is carbon dioxide gas held in flavoured water under pressure. When the cap is removed pressure decreases and the gas comes out of solution. As cold deep water rises through upwelling ocean currents it becomes warmer and outgasses carbon dioxide into the atmosphere. Similarly atmospheric warming due to the enhanced Greenhouse Effect will release more carbon dioxide producing a positive feedback loop.

Plants and animals in the ocean absorb the soluble bicarbonate ions and turn them into insoluble carbonates with which to build shells and skeletons. Coral reefs are carbonate sinks and are made from the skeletons of coral. Carbonates are also deposited as ooze in warm tropical oceans. Soluble bicarbonates often form the cement that turns sediment into sedimentary rock during the process of lithification.



Solution - Teacher Notes

Note: Combustion Carbon in living organisms or their fossilised remains (fossil fuels such as coal, oil and gas) can be burned with oxygen to produce energy, water and carbon dioxide. In third world countries land is often cleared for agriculture by setting fire to vegetation. Fire removes the vegetation and provides some fertiliser from ash. Fire is also used to remove weeds and straw after harvest. In both cases most of the carbon stored in the biosphere is removed to the atmosphere.

Combustion activities are found in the "Carbon Chemistry" section.

References

[1] Ocean Carbon Uptake, National Oceanic and Atmospheric Adminstration, accessed at http://www.pmel.noaa.gov/co2/story/Ocean+Carbon+Uptake, accessed on May 6th, 2014