STEM Sims™

Negative Cement

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Do you need an idea for a scientific study?
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Start learning right now about carbon's environmental impacts. Take the following brief quiz to see how much you already know about carbon negative cement. See the bottom of page 4 to check your answers.

1. What percent of the world's carbon dioxide emissions currently come from cement production?
   a. 1%
   b. 5%
   c. 10%
   d. 15%

2. Which material absorbs carbon dioxide in carbon negative cement?
   a. quartz (SiO_2)
   b. calcite ($CaCO_3$)
   c. fluorite (CaF_2)
   d. magnesium oxide (MgO)

3. When was Sorel cement first discovered?
   a. 1867
   b. 1901
   c. 1976
   d. 2009

4. How much CO_2 is typically released from limestone per metric ton of cement?
   a. 100 kg (~220 lbs)
   b. 250 kg (~550 lbs)
   c. 400 kg (~880 lbs)
   d. 600 kg (~1320 lbs)

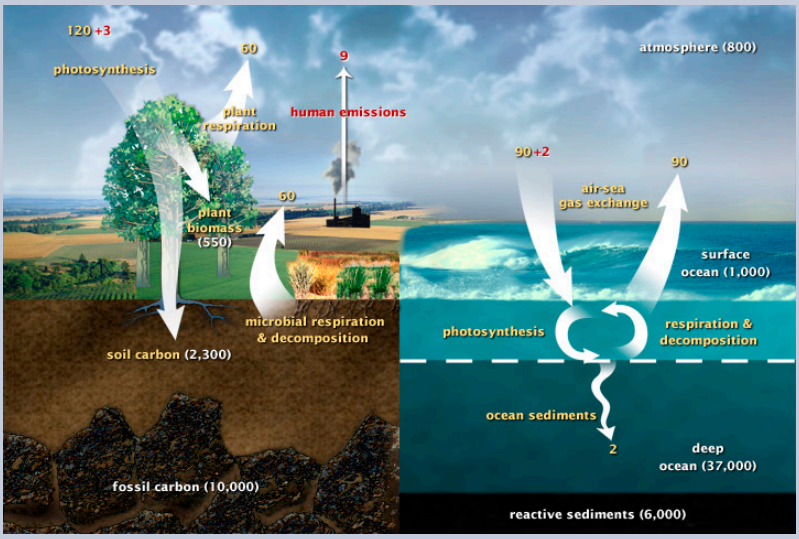
5. According to Novacem, one of the first companies to test carbon negative cement, how much CO_2 can be absorbed per metric ton of cement during their production process?
   a. 0-30 kg
   b. 30-100 kg
   c. 100-230 kg
   d. 230-300 kg

The Ins and Outs of Carbon Dioxide

Carbon dioxide (CO_2) is an interesting substance: for humans, it is a toxic waste product of the metabolic system, and for plants it is a necessary part of photosynthesis to obtain nutrients. Humans require oxygen and excrete carbon dioxide while plants require carbon dioxide and excrete oxygen. Unfortunately the balance has been upset; since the Industrial Revolution, burning fossil fuels has dramatically increased the amount of carbon dioxide in the atmosphere. Carbon dioxide is a greenhouse gas, meaning it absorbs and traps heat that should have left the atmosphere.

Use the following information to answer the questions below.

- Humans inhale about 550 liters of pure oxygen per day and exhale ~1 kg (2.3 lbs) of CO_2 daily.
- One tree can absorb CO_2 at a rate of 48 lbs per year and produces nearly 260 lbs of oxygen each year.
- An average car emits .916 pounds of carbon dioxide per mile.



1. Approximately how many pounds of CO_2 does a human exhale per year?

2. How many trees would be needed so that the amount of CO_2 absorbed is equal to the amount exhaled by one person?

3. If a car was driven from Washington DC to NYC (227 mi) and back, how many pounds of CO_2 total would it emit?

4. If there were 3 people in the car for 3 hours and 45 minutes, how many kilograms of CO_2 total would they exhale?

5. If a family of 5 took a road trip from Seattle, WA to Miami, FL (1 day 23 hours, 3,297 miles), how many pounds of CO_2 would the car and the five people generate on their trip?

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Uncementing Your Carbon Footprint

In applications like green engineering, “carbon footprint” is a term used to connote how much carbon dioxide (CO_2) and methane (CH_4) a person or group uses. Unfortunately, the cement business currently generates lots of carbon dioxide due to the original materials being used as well as the process required to make the cement (including the fuels necessary to generate high temperatures). In 2009, the International Energy Agency and the World Business Council for Sustainable Development worked together to map out the cement technology industry and where its future lies, especially in the context of reducing carbon emissions. One of the four big pushes is for carbon capture and storage (CCS).

The Roadmap identified various types of low carbon and carbon negative cements that are being developed. Geopolymer cement reduces its carbon footprint by recycling materials that normally would have gone to waste, such as ash and slag. The magnesium silicates used in Novacem’s cement not only take less CO_2 to harvest than say limestone, but they also absorb CO_2 in the process of producing carbonates.

The Roadmap also highlights impediments to the progress of reducing carbon emissions. The first barrier to implementation is cost. In many green engineering applications, monetary cost is often a big hurdle to overcome, as normal practice often looks for the bottom line of economics without consideration to the ecological ramifications. Another barrier is political. In order for CCS to succeed, the government’s financial support through incentives and research and development (R&D) is likely to be required. It is also necessary that the property owners and local residents approve the implementation. The last barrier is education. The general public needs to be made aware of the benefits of replacing older models with costlier yet more environmentally friendly cement alternatives in order to gain the support required.

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Answers: **Page 2 Answers**: 1) b. 2) d. 3) a. 4) c. 5) b. **Page 3 Answers**: 1) ~840 lbs 2) 18 trees. 3) ~416 pounds. 4) 0.47 kg. 5) 3042 lbs.

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