

## Concrete solutions

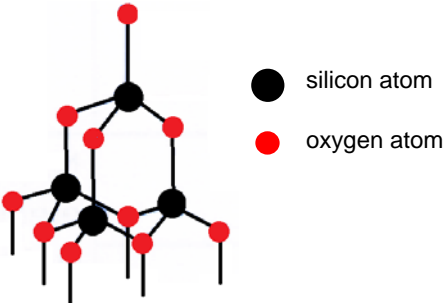
### *Education in Chemistry*

September 2020

[rsc.li/2ZyA0jZ](https://rsc.li/2ZyA0jZ)

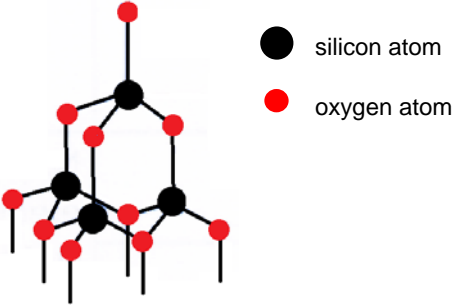
The following questions linked to the article *Concrete solutions* need you to think back to earlier chemistry units and retrieve key knowledge.

Question	Answer
Concrete is an example of a <b>composite</b> material. State <b>two</b> other composite materials.	
The article describes how cement and therefore concrete can be produced more sustainably. Describe what we mean when we say a process is <b>sustainable</b> .	
Cement is formed by heating powdered limestone with clay. During this process, the calcium carbonate in the limestone undergoes <b>thermal decomposition</b> . Define what is meant by thermal decomposition.	
Calcium carbonate has the formula $\text{CaCO}_3$ . State the number of <b>elements</b> in calcium carbonate.	
State the number of <b>atoms</b> in calcium carbonate.	
Calcium carbonate ( $\text{CaCO}_3$ ) is an ionic compound. Calcium is in group 2. State the charge on the calcium ion in calcium carbonate.	
Calculate the relative formula mass of calcium carbonate ( $\text{CaCO}_3$ ). Relative atomic masses: Ca 40; C 12; O 16	

<p>Describe the analytical test you would use to show the presence of calcium ions in a compound.</p>	
<p>Sand is added to cement, stones and water to make concrete. A common form of sand is composed of silica.</p> <p>Silica is a macromolecule. The bonding in silica is shown below:</p>  <p>Use your understanding of the bonding in a macromolecule to explain why silica has a very high melting point.</p>	
<p>Carbon dioxide is a <b>greenhouse gas</b>.</p> <p>Name two other greenhouse gases.</p>	
<p>The early atmosphere was mostly carbon dioxide. Today the atmosphere is just 0.04% carbon dioxide.</p> <p>Describe <b>one</b> process that reduced the amount of carbon dioxide in the atmosphere over the last 4.5 billion years.</p>	
<p>The percentage of carbon dioxide in the atmosphere today is slowly increasing.</p> <p>State <b>one</b> way that human activity is increasing the levels of carbon dioxide in the atmosphere today.</p>	
<p>Describe what is meant by the <b>carbon footprint</b> of a product.</p>	
<p>Give <b>two</b> ways, described in the article, that scientists hope to reduce the carbon footprint of concrete in the future.</p>	

## Answers

Question	Answer
<p>Concrete is an example of a <b>composite</b> material.</p> <p>State <b>two</b> other composite materials.</p>	<p>Possible answers include:</p> <ul style="list-style-type: none"> <li>• Fibreglass</li> <li>• Carbon fibre</li> <li>• Concrete</li> <li>• Wood</li> <li>• Reinforced concrete</li> </ul>
<p>The article describes how cement and therefore concrete can be produced more sustainably.</p> <p>Describe what we mean when we say a process is <b>sustainable</b>.</p>	<p>Capable of being maintained at a steady level without exhausting natural resources or causing environmental or ecological damage.</p>
<p>Cement is formed by heating powdered limestone with clay.</p> <p>During this process, the calcium carbonate in the limestone undergoes <b>thermal decomposition</b>.</p> <p>Define what is meant by thermal decomposition.</p>	<p>A reaction in which one substance is broken down into two or more substances using heat.</p>
<p>Calcium carbonate has the formula <math>\text{CaCO}_3</math>.</p> <p>State the number of <b>elements</b> in calcium carbonate.</p>	<p>3 elements (calcium, carbon and oxygen)</p>
<p>State the number of <b>atoms</b> in calcium carbonate</p>	<p>5 atoms (1 × Ca, 1 × C and 3 × O)</p>
<p>Calcium carbonate (<math>\text{CaCO}_3</math>) is an ionic compound.</p> <p>Calcium is in group 2.</p> <p>State the charge on the calcium ion in calcium carbonate.</p>	<p>2+</p>
<p>Calculate the relative formula mass of calcium carbonate (<math>\text{CaCO}_3</math>).</p> <p>Relative atomic masses: Ca 40; C 12; O 16</p>	<p><math>40 + 12 + (3 \times 16)</math> = <b>100</b></p>
<p>Describe the analytical test you would use to show the presence of calcium ions in a compound.</p>	<p>Flame test – heat the unknown substance in a blue Bunsen flame. A characteristic orange-red flame is observed.</p>

<p>Sand is added to cement, stones and water to make concrete. A common form of sand is composed of silica.</p> <p>Silica is a <b>macromolecule</b>. The bonding in silica is shown below:</p>  <p>Use your understanding of the bonding in a macromolecule to explain why silica has a very high melting point.</p>	<p>To melt a macromolecule you need to break strong covalent bonds.</p> <p>This requires a lot of energy.</p>
<p>Carbon dioxide is a <b>greenhouse gas</b>.</p> <p>Name two other greenhouse gases.</p>	<ul style="list-style-type: none"> <li>• Methane</li> <li>• Water vapour</li> </ul>
<p>The early atmosphere was mostly carbon dioxide. Today the atmosphere is just 0.04% carbon dioxide.</p> <p>Describe <b>one</b> process that reduced the amount of carbon dioxide in the atmosphere over the last 4.5 billion years.</p>	<p>Any one of:</p> <ul style="list-style-type: none"> <li>• Once oceans had formed the carbon dioxide dissolved in the oceans. The dissolved carbon dioxide then underwent a series of reactions to form carbonate precipitates that formed sediments on the sea bed.</li> <li>• Green plants evolved and removed carbon dioxide through photosynthesis.</li> <li>• Marine animals evolved. Their shells and skeletons contained carbonates from the oceans.</li> </ul>
<p>The percentage of carbon dioxide in the atmosphere today is slowly increasing.</p> <p>State <b>one</b> way that human activity is increasing the levels of carbon dioxide in the atmosphere today.</p>	<p>Any one of:</p> <ul style="list-style-type: none"> <li>• Burning fossil fuels (allow any activity that involves the burning of fossil fuels)</li> <li>• Increased human population</li> <li>• Deforestation</li> </ul>
<p>Describe what is meant by the <b>carbon footprint</b> of a product.</p>	<p>A carbon footprint is a measure of the amount of carbon dioxide and other greenhouse gases released over the full life cycle of a product.</p>
<p>Give <b>two</b> ways, described in the article, that scientists hope to reduce the carbon footprint of concrete in the future.</p>	<p>Any two of:</p> <ul style="list-style-type: none"> <li>• Add other materials that produce less CO<sub>2</sub> to the mix, for example ground granulated blast-furnace slag (a by-product from steel production) or fly ash (a by-product from the</li> </ul>

	<p>coal industry).</p> <ul style="list-style-type: none"><li>• Add pozzolans such as calcined clay to the concrete.</li><li>• Incorporate dried, crushed wood into the cement.</li></ul>
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