

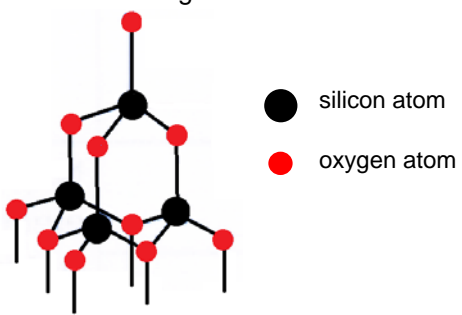
Concrete solutions

Education in Chemistry

September 2020

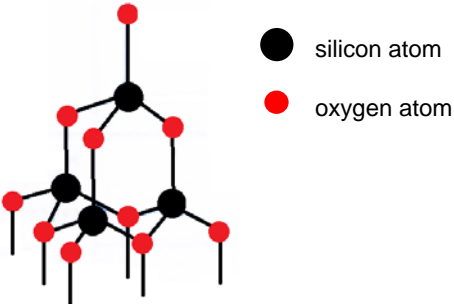
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The following questions linked to the article *Concrete solutions* require you to think back to earlier chemistry units and retrieve key knowledge.

Question	Answer
<p>Concrete is an example of a composite material.</p> <p>State two other composite materials.</p>	
<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 sustainable.</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 in the image below:</p>  <p>Use your understanding of the bonding in a macromolecule to explain why silica has a very high melting point.</p>	
<p>Cement is formed by heating powdered limestone with clay.</p> <p>During this process, the calcium carbonate in the limestone undergoes thermal decomposition.</p> <p>Define what is meant by thermal decomposition.</p>	

<p>Calcium carbonate is an ionic compound. Its formula is CaCO₃.</p> <p>State the charge on a) a calcium ion and b) a carbonate ion.</p>	
<p>Describe the analytical test for:</p> <p>a) calcium ions</p> <p>b) carbonate ions</p>	
<p>Calculate the molar mass of CaCO₃.</p> <p>A_r Ca 40 g/mol; C 12 g/mol; O 16 g/mol</p>	
<p>When calcium carbonate undergoes thermal decomposition calcium oxide and carbon dioxide are produced. The balanced symbol equation for this reaction is:</p> $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ <p>Calculate the mass of carbon dioxide released when 150 tonnes of calcium carbonate undergo thermal decomposition.</p> <p>1 tonne = 1 000 000 g</p>	
<p>Carbon dioxide is a greenhouse gas.</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 three processes that brought about this change.</p>	
<p>Describe what is meant by the carbon footprint of a product.</p>	
<p>Give two 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 composite material.</p> <p>State two other composite materials.</p>	<p>Possible answers include:</p> <ul style="list-style-type: none"> • Fibreglass • Carbon fibre • Concrete • Wood • Reinforced concrete
<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 sustainable.</p>	<p>Capable of being maintained at a steady level without exhausting natural resources or causing environmental or ecological damage.</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 in the image 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>Cement is formed by heating powdered limestone with clay.</p> <p>During this process, the calcium carbonate in the limestone undergoes thermal decomposition.</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 is an ionic compound. Its formula is CaCO₃.</p> <p>State the charge on a) a calcium ion and b) a carbonate ion.</p>	<p>a) Ca²⁺ b) CO₃²⁻</p>
<p>Describe the analytical test for:</p> <p>a) Calcium ions</p>	<p>a) Flame test – heat the unknown substance in a blue Bunsen flame. A characteristic orange-red flame is observed.</p>

b) Carbonate ions	b) In a test tube, add a couple of drops of dilute acid to the unknown substance. Bubble the gas produced through limewater. A positive result is indicated by the limewater turning cloudy owing to the formation of carbon dioxide.
Calculate the molar mass of CaCO ₃ . A _r Ca 40 g/mol; C 12 g/mol; O 16 g/mol	40 + 12 + (3 × 16) = 100 g/mol
When calcium carbonate undergoes thermal decomposition calcium oxide and carbon dioxide are produced. The balanced symbol equation for this reaction is: $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ Calculate the mass of carbon dioxide released when 150 tonnes of calcium carbonate undergo thermal decomposition. 1 tonne = 1 000 000 g	150 tonnes = 150 000 000 g Amount in moles of CaCO ₃ in 150 000 000 g $= \frac{150\,000\,000\text{ g}}{100\text{ g/mol}} = 1\,500\,000\text{ mol}$ Each mole of CaCO ₃ produced one mole of CO ₂ Amount in moles of CO ₂ produced: = 1 500 000 mol Mass of CO ₂ produced: = 1 500 000 mol × 44 g/mol = 66 000 000 g = 66 tonnes
Carbon dioxide is a greenhouse gas . Name two other greenhouse gases.	<ul style="list-style-type: none"> • Methane • Water vapour
The early atmosphere was mostly carbon dioxide. Today's atmosphere is just 0.04% carbon dioxide. Describe three processes that brought about this change.	<ol style="list-style-type: none"> 1. 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. 2. Green plants evolved and removed carbon dioxide through photosynthesis. 3. Marine animals evolved. Their shells and skeletons contained carbonates from the oceans.
Describe what is meant by the carbon footprint of a product.	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.
Give two ways, described in the article, that scientists hope to reduce the carbon footprint of concrete in the future.	<ol style="list-style-type: none"> 1. Add other materials that produce less CO₂ to the mix, for example ground granulated blast-furnace slag (a by-product from steel production) or fly ash (a by-product from the coal industry) 2. Add pozzolans such as calcined clay to the concrete. 3. Incorporate dried, crushed wood into the cement.