Q1. The article gives some information about graphene.

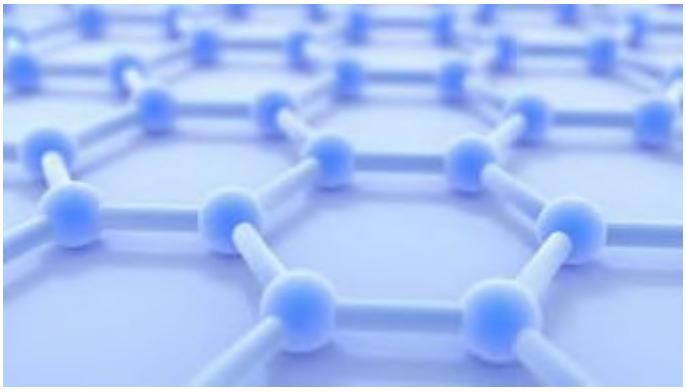
Nanotunes!

Carbon can be made into nano-thin, strong sheets called graphene.

A graphene sheet is a single layer of graphite.

Graphene conducts electricity and is used in loudspeakers.

The picture shows the structure of graphene.



© 7immy/iStock

(a) Use the picture and your knowledge of bonding in graphite to:

(i) explain why graphene is strong;

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(3)

(ii) explain why graphene can conduct electricity.

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(2)

(b) Graphite is made up of layers of graphene.

Explain why graphite is a lubricant.

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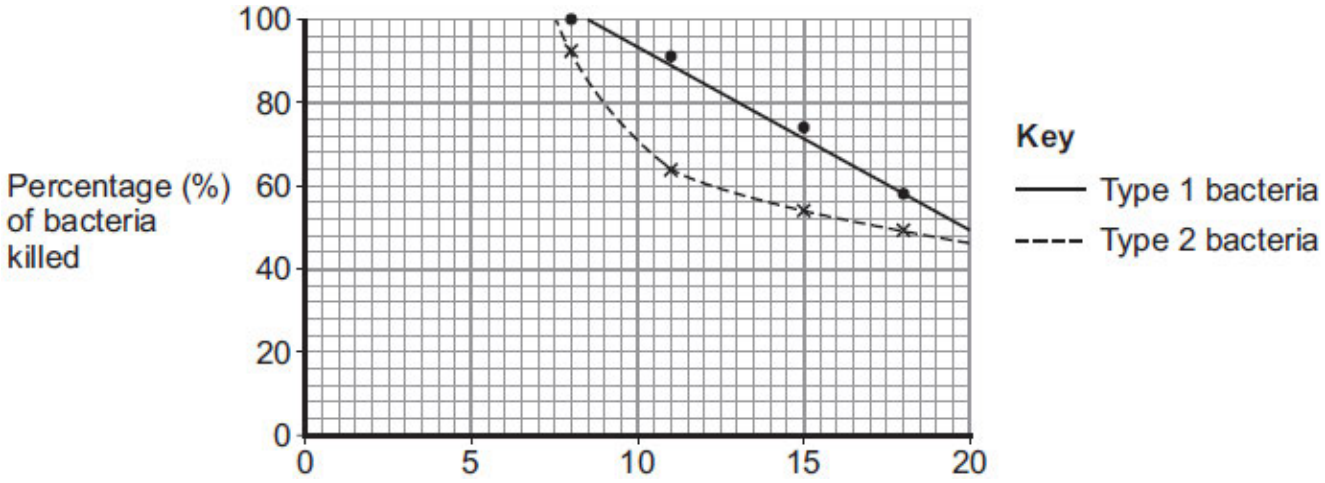
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(2)
(Total 7 marks)

Q2. Magnesium oxide nanoparticles can kill bacteria.

The figure below shows the percentage of bacteria killed by different sized nanoparticles.



(a) (i) Give **two** conclusions that can be made from the figure above.

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(2)

(ii) Points are plotted for only some sizes of nanoparticles.

Would collecting and plotting data for more sizes of nanoparticles improve the conclusions?

Give a reason for your answer.

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(1)

(b) Magnesium oxide contains magnesium ions (Mg^{2+}) and oxide ions (O^{2-}).

Describe, as fully as you can, what happens when magnesium atoms react with oxygen atoms to produce magnesium oxide.

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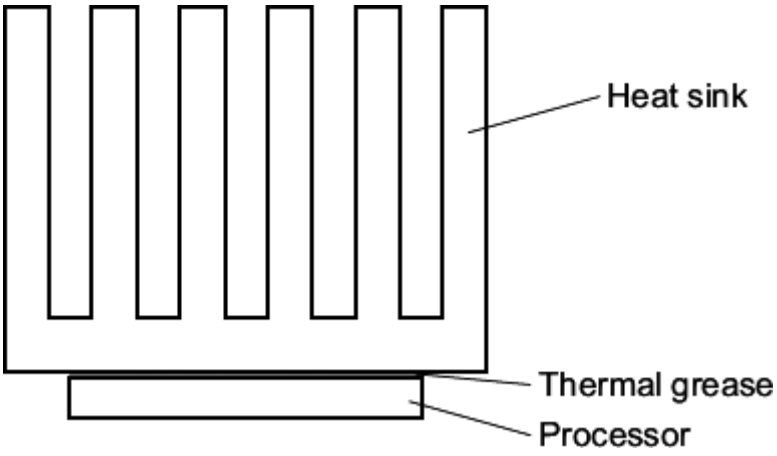
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(4)
(Total 7 marks)

Q3. The diagram shows how a heat sink is placed on top of a processor in a computer. The heat sink is a large piece of metal which conducts heat away from the processor. If the processor gets too hot it may be damaged.



(a) (i) Describe the structure of a metal.

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(3)

(ii) Why are metals very good conductors of heat?

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(1)

(b) When viewed under a microscope, it can be seen that the surfaces of the processor and the heat sink that are in contact are not flat.

There are lots of tiny gaps between the two surfaces.
The gaps contain air, which does not conduct heat very well.
Thermal grease is used to fill the gaps between the processor and the heat sink to improve the transfer of heat from the processor to the heat sink.

One type of thermal grease contains nanosized particles of silver.
The manufacturer claims that the nanosized particles help to transfer heat better than normal sized particles.

(i) How are nanosized particles different from normal sized particles?

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(1)

(ii) Suggest **one** reason why nanosized particles of silver might help to transfer heat better than normal sized particles.

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(1)
(Total 6 marks)

Q4. This question is about calcium hydroxide.

Ancient artworks and monuments can be protected from acid rain if the surface is sprayed with calcium hydroxide nanoparticles.



By Svilen Enev (Own work) [GFDL or CC-BY-SA-3.0], via Wikimedia Commons

(a) Calcium hydroxide has the formula $Ca(OH)_2$

Why are there two hydroxide ions for each calcium ion in the formula?

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(1)

(b) The calcium hydroxide is used in the form of *nanoparticles*.

What are *nanoparticles*?

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(1)

(c) A student added water to calcium oxide to make calcium hydroxide.

The equation for the reaction is shown below.

$$CaO + H_2O \rightarrow Ca(OH)_2$$

Calculate the maximum mass of calcium hydroxide which could be made from 2.00 g of calcium oxide.

Relative atomic masses (A_r): H = 1; O = 16; Ca = 40.

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Maximum mass of calcium hydroxide = ... g

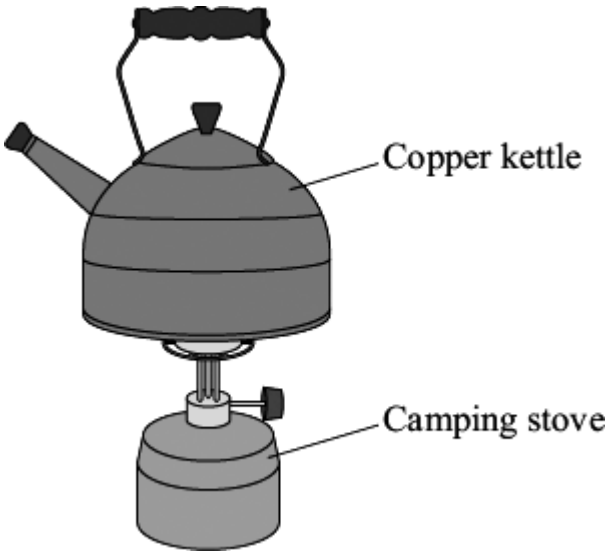
(3)

(Total 5 marks)

Q5. The picture shows a copper kettle being heated on a camping stove.

Copper is a good material for making a kettle because:

- it has a high melting point
- it is a very good conductor of heat.



(a) Explain why copper, like many other metals, has a high melting point.
You should describe the structure and bonding of a metal in your answer.

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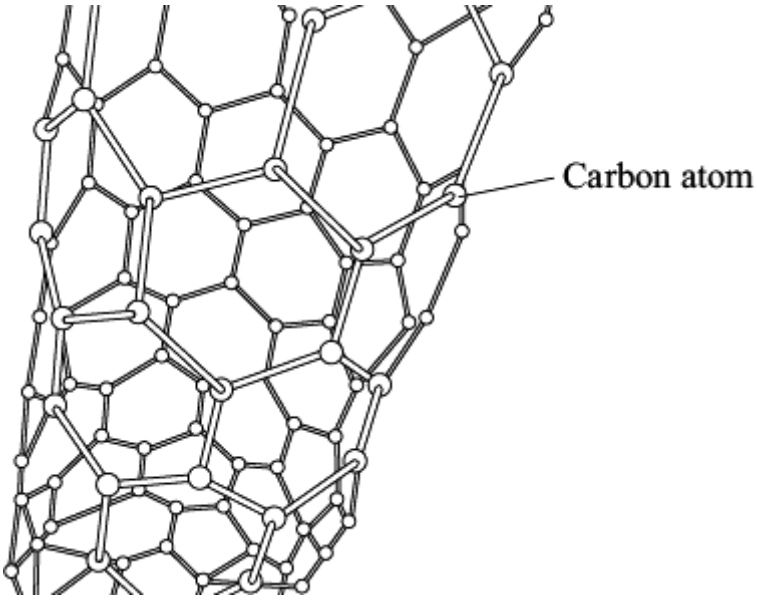
(4)

(b) An aeroplane contains many miles of electrical wiring made from copper. This adds to the mass of the aeroplane.

It has been suggested that the electrical wiring made from copper could be replaced by

lighter carbon nanotubes.

The diagram shows the structure of a carbon nanotube.



(i) What does the term 'nano' tell you about the carbon nanotubes?

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(1)

(ii) Like graphite, each carbon atom is joined to three other carbon atoms.

Explain why the carbon nanotube can conduct electricity.

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(2)
(Total 7 marks)

Q6. Read the article about the use of nanoparticles in sun creams.

Sun creams

Many sun creams use nanoparticles. These sun creams are very good at absorbing radiation, especially ultraviolet radiation. Owing to the particle size, the sun creams spread more easily, cover better and save money because you use less. The new sun creams are also transparent, unlike traditional sun creams which are white. The use of nanoparticles is so successful that they are now used in more than 300 sun cream products.

Some sun creams contain nanoparticles of titanium oxide. Normal-sized particles of titanium oxide are safe to put on the skin.

It is thought that nanoparticles can pass through the skin and travel around the body more easily than normal-sized particles. It is also thought that nanoparticles might be toxic to some types of cell, such as skin, bone, brain and liver cells.

(a) Explain why nanoparticles pass through the skin and travel around the body more easily than normal-sized particles of titanium oxide.

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(2)

(b) Explain why sun creams containing nanoparticles should be tested further.

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(1)

(c) Suggest why some companies that make sun creams might not want to do more tests.

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(2)
(Total 5 marks)