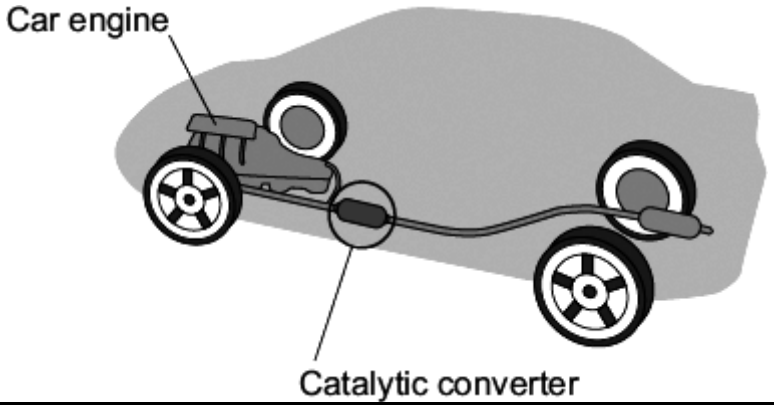
Q1. Read the information about car engines.

Burning petrol in air is an *exothermic* reaction. This reaction is used in car engines.

When petrol burns it produces harmful substances such as nitrogen oxides and carbon monoxide.

A catalytic converter stops these harmful substances being released into the air.



(a) The reaction is *exothermic*. What is the meaning of *exothermic*?

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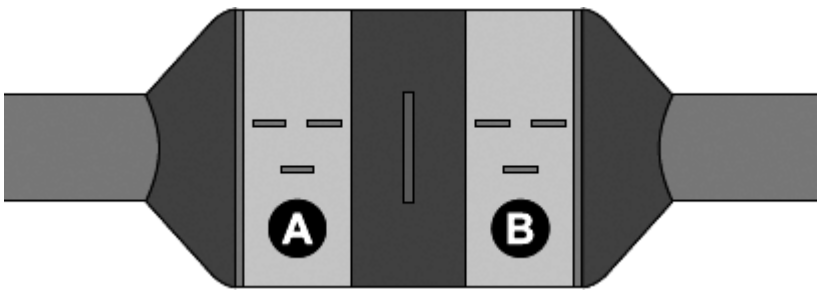
(1)

(b) The catalytic converter has two parts shown as **A** and **B** in the diagram.



Part **A** contains a catalyst made from platinum and rhodium.

Part **B** contains a catalyst made from platinum and palladium.

(i) Why are catalysts used in chemical reactions?

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(1)

(ii) One reaction in part **A** is shown by this equation.

$2NO \rightarrow N_2 + O_2$

Suggest why this reaction helps the environment.

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(1)

(iii) The equation for one of the reactions in part **B** is shown below.

Balance this equation.

..... $CO + O_2 \rightarrow$ ..... CO_2

(1)

(iv) The catalytic converter works for many years without replacing the catalyst.

Explain why the catalyst does not need to be replaced.

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(1)

(v) Suggest why different catalysts are used in parts **A** and **B**.

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(1)

(c) Modern catalytic converters contain nanosized particles of catalyst. Using nanosized particles reduces the cost of the catalytic converter.

Suggest and explain why the use of nanosized catalyst particles reduces the cost of the catalytic converter.

Your answer should include information about the size and surface area of the particles.

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(3)
(Total 9 marks)

Q2. Read the article and then answer the questions that follow.

Nanotennis!

Tennis balls contain air under pressure, which gives them their bounce. Normal tennis balls are changed at regular intervals during tennis matches because they slowly lose some of the air. This means that a large number of balls are needed for a tennis tournament, using up a lot of materials.

'Nanocoated' tennis balls have a 'nanosize' layer of butyl rubber. This layer slows down the escape of air so that the ball does not lose its pressure as quickly. The 'nanocoated' tennis balls last much longer and do not need to be replaced as often.

(a) How does the 'nanosize' layer make the tennis balls last longer?

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(1)

(b) Put a tick (✓) next to the best description of a 'nanosize' layer.

Description	(✓)
A layer one atom thick.	
A layer a few hundred atoms thick.	
A layer millions of atoms thick.	

(1)

(c) Suggest why using 'nanocoated' tennis balls would be good for the environment.

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(2)
(Total 4 marks)

Q3. Read the article and then answer the questions.

Nanotennis!

Tennis balls contain air under pressure, which gives them their bounce. Normal tennis balls are changed at regular intervals during tennis matches because they slowly lose some of the air.

'Nanocoated' tennis balls have a 'nanosize' layer of butyl rubber. This layer slows down the escape of air so that the ball does not lose its pressure as quickly.

(a) What is the meaning of *nanosize*?

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(1)

(b) Suggest why using 'nanocoated' tennis balls would be good for the environment.

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(2)
(Total 3 marks)

Q4. Read this passage about metals.

Metals are crystalline materials. The metal crystals are normally about 20 000 nm (nanometres) in diameter. The atoms inside these crystals are arranged in layers.

A new nanoscience process produces nanocrystalline metals. Nanocrystalline metals are stronger and harder than normal metals.

It is hoped that nanocrystalline metals can be used in hip replacements.

The use of nanocrystalline metals should give people better hip replacements which last longer.

(a) State why metals can be bent and hammered into different shapes.

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(1)

(b) How is the size of the crystals in nanocrystalline metals different from the size of the crystals in normal metals?

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(1)

(c) Hip joints are constantly moving when people walk.

Suggest and explain why the hip replacement made of nanocrystalline metal should last longer than one made of normal metals.

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(2)
(Total 4 marks)