Q1. The figure below shows magnesium burning in air.



© Charles D Winters/Science Photo Library

(a) Look at the figure above.

How can you tell that a chemical reaction is taking place?

.....

.....

(1)

(b) Name the product from the reaction of magnesium in the figure.

.....

(1)

(c) The magnesium needed heating before it would react.

What conclusion can you draw from this?

Tick **one** box.

The reaction is reversible ☐

The reaction has a high activation energy ☐

The reaction is exothermic ☐

Magnesium has a high melting point ☐

(1)

(d) A sample of the product from the reaction in the figure above was added to water and shaken.

Universal indicator was added.

The universal indicator turned blue.

What is the pH value of the solution?

Tick **one** box.

1 ☐

4 ☐

7 ☐

9 ☐

(1)

(e) Why are nanoparticles effective in very small quantities?

Tick **one** box.

They are elements ☐

They are highly reactive ☐

They have a low melting point ☐

They have a high surface area to volume ratio ☐

(1)

(f) Give **one** advantage of using nanoparticles in sun creams.

.....

.....

(1)

(g) Give **one** disadvantage of using nanoparticles in sun creams.

.....

.....

(1)

(h) A coarse particle has a diameter of 1×10^{-6} m.
A nanoparticle has a diameter of 1.6×10^{-9} m.

Calculate how many times bigger the diameter of the coarse particle is than the diameter of the nanoparticle.

.....

.....

.....

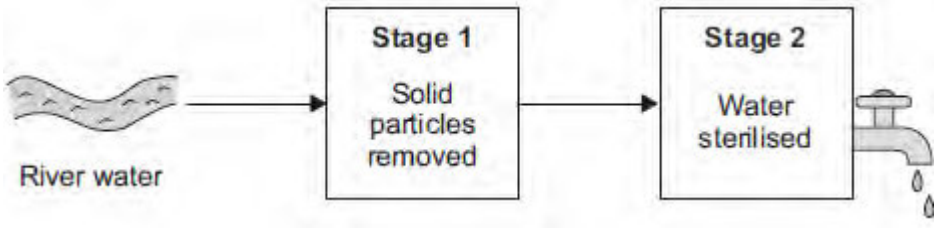
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(2)
(Total 9 marks)

Q2. This question is about water.

River water needs to be treated before it is safe to drink.

(a) The diagram shows two stages of the treatment of river water.



(i) What is the name of the process used to remove solid particles in **Stage 1**?

Tick (✓) **one** box.

Crystallisation ☐

Fermentation ☐

Filtration ☐

(1)

(ii) What is added in **Stage 2** to sterilise the water?

Tick (✓) **one** box.

Chlorine ☐

Fluoride ☐

Potassium ☐

(1)

(b) Toxic substances in river water are removed by adding very small amounts of iron oxide nanoparticles.

(i) How is the size of nanoparticles different from normal-sized particles?

.....

.....

(1)

(ii) Nanoparticles are needed in only very small amounts.

Suggest why.

.....

.....

(1)

(c) In certain areas of the UK, tap water contains aluminium ions.

What would you **see** when sodium hydroxide solution is added drop by drop to tap water containing aluminium ions?

.....

.....

.....

.....

(2)
(Total 6 marks)

.

Q3. This question is about diamonds.

Draw a ring around the correct answer to complete each sentence.

(a) Diamonds are found in meteorites.

(i) Meteorites get very hot when they pass through the Earth's atmosphere, but the diamonds do not melt.

Diamond has a (high / low / very low) melting point.

(1)

(ii) Most diamonds found in meteorites are nanodiamonds.

A nanodiamond contains a few (hundred / thousand / million.) atoms

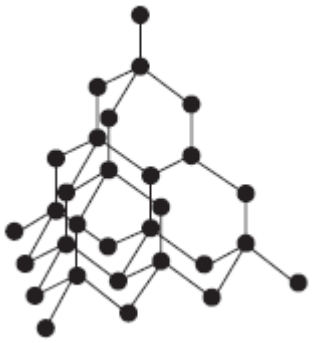
(1)

(b) Diamonds are used for the cutting end of drill bits.

Diamonds can be used for drill bits because they are (hard. / shiny. / soft.)

(1)

(c) The figure below shows the arrangement of atoms in diamond.



(i)

Diamond is made from [carbon / nitrogen / oxygen] atoms.

(1)

(ii)

Each atom in diamond is bonded to [three / four / five] other atoms.

(1)

(iii)

[covalent]

Diamond has a giant | ionic / metallic | structure.

(1)

(iv)

In diamond | all / none / some | of the atoms are bonded together.

(1)
(Total 7 marks)

Q4. 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. This means that a large number of balls are needed for a tennis tournament.



© Feng Yu/iStock

'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) Tick (✓) the best description of a 'nanosize' layer.

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

(1)

(b) Suggest **two** ways in which using 'nanocoated' tennis balls would be good for the environment.

.....

.....

.....

.....

.....

(2)
(Total 3 marks)

Q5. Nanoparticles have many uses.

(a) (i) Tick (✔) **one** use of nanoparticles.

In the extraction of iron ☐

In suntan creams ☐

In the test for oxygen ☐

(1)

(ii) How is the size of nanoparticles different from normal-sized particles?

Draw a ring around the correct answer.

much smaller **same size** **much larger**

(1)

(b) Very small amounts of cerium oxide nanoparticles can be added to diesel fuel.

The cerium oxide is a catalyst.

(i) Draw a ring around the correct answer to complete the sentence.

Only a very small amount of cerium oxide nanoparticles is needed because

the nanoparticles

are elements.
are very reactive.
have a high surface area to volume ratio.

(1)

(ii) Explain how a catalyst increases the rate of a reaction.

.....

.....

.....

.....

.....

(2)
(Total 5 marks)

Q6. Gold and gold ions are used as catalysts.

(a) An atom of gold is represented as:

$$^{197}_{79}\mathrm{Au}$$

Complete the sentences.

The atomic number of gold is .....

The number of electrons in an atom of gold is .....

(2)

(b) Scientists have found that gold nanoparticles are very good catalysts.

Draw a ring around the correct answer to complete the sentence.

A gold nanoparticle contains a few | hundred / thousand / million | atoms.

(1)

(c) The formation of a gold ion (Au^{3+}) from a gold atom (Au) is shown in the symbol equation.

$$Au \rightarrow Au^{3+} + 3e^-$$

(i) Complete the sentence.

The particles lost when a gold atom becomes a gold ion

are called .....

(1)

(ii) Draw a ring around the correct answer to complete the sentence.

one.

The number of these particles lost when a gold atom becomes a gold ion is

two.
three.

(1)

(d) Gold ions are used as a catalyst in the reaction to make chloroethene.

How does a catalyst help a reaction?

.....

(1)

(e) Chloroethene can react to make a thermosoftening polymer.

(i) Draw a ring around the correct answer to complete the sentence.

When heated, a thermosoftening polymer will

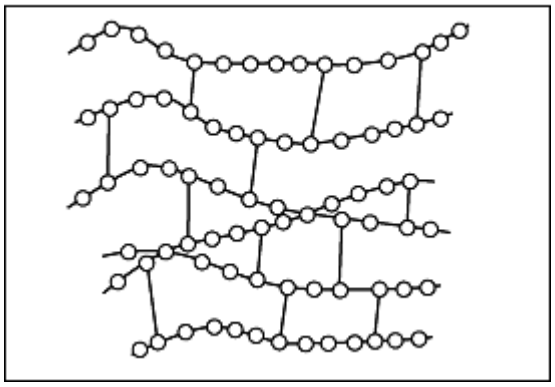
dissolve.
melt.
solidify.

(1)

(ii) Polymer **B** is a different type of polymer.

The diagram shows the structure of polymer **B**.

Polymer B



How can you tell from the diagram that polymer **B** is **not** thermosoftening?

.....

.....

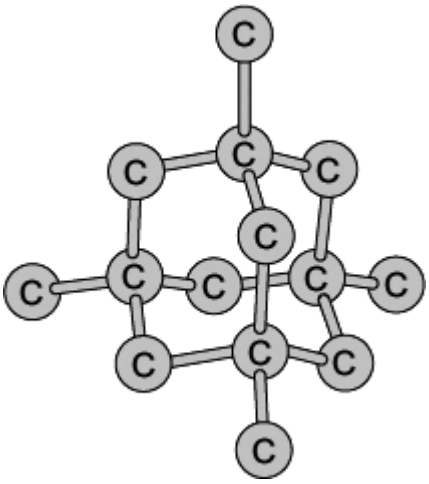
(1)

(Total 8 marks)

Q7. Liquids containing nanoparticles of diamond are used as abrasives.Nanoparticles of diamond can be used to grind down surfaces to give them a very smooth polished finish.



Abrasive liquid containing nanoparticles of diamond



Model of part of the diamond structure

(a) Diamond is made of one element.
Draw a ring around the name of this element.

calcium **carbon** **chromium** **cobalt**

(1)

(b) Tick (✓) **two** statements in the table which explain why diamond is hard.

Statement	Tick (✓)
It is made of layers.	
It has weak covalent bonds.	
Each atom is joined to four other atoms.	
It has a giant structure.	
It has strong ionic bonds.	

(2)

(c) Draw a ring around the correct answer to complete the sentence.

Nanoparticles of diamond are

very small.

large.

very large.

(1)

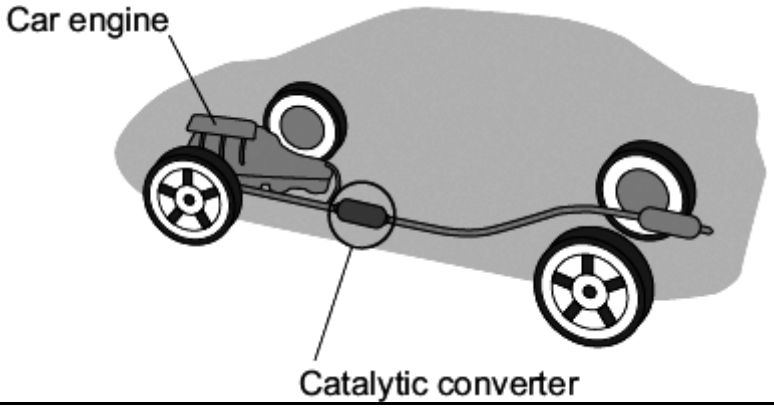
(Total 4 marks)

Q8. 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) Draw a ring around the correct answer to complete each sentence.

(i) The exothermic reaction makes the temperature of the engine

decrease.

increase.

stay the same.

(1)

(ii) This is because during exothermic reactions

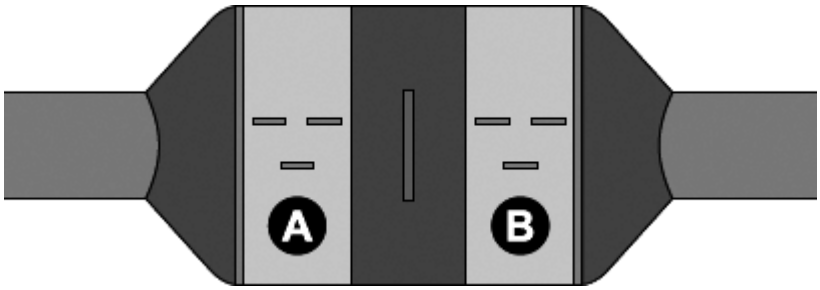
energy is taken in from the surroundings.

energy is given out to the surroundings.

there is no energy change.

(1)

(b) The diagram shows a catalytic converter which removes harmful substances.
The catalytic converter has two parts, **A** and **B**, which contain different catalysts.



(i) The equation for the reaction that takes place in part **A** is:

$2NO \rightarrow N_2 + O_2$

Which **one** of the substances shown in the equation is a compound?

Give the formula of this compound.

.....

(1)

(ii) The equation for the reaction that takes place in part **B** is:

$2CO + O_2 \rightarrow 2CO_2$

Why is it important to stop carbon monoxide (CO) from being released into the air?

.....

.....

(1)

(c) The table lists some statements about catalysts. Only **two** statements are correct.

Tick (✓) the **two** correct statements.

Statement	**Tick (✓)**
A catalyst can speed up a chemical reaction.	
A catalyst is used up in a chemical reaction.	
Different reactions need different catalysts.	

A catalyst does **not** change the rate of a chemical reaction.	

(2)

(d) Modern catalytic converters contain nanosized particles of catalyst.
Less catalyst is needed when nanosized catalyst particles are used.

(i) Complete the sentence.

The size of nanosized particles is ..... than normal sized particles.

(1)

(ii) The catalysts contain platinum.

Suggest why a manufacturer of catalytic converters would want to use less catalyst.

.....

.....

(1)
(Total 8 marks)

Q9. Read the article and then answer the questions.

TOXIC SOCKS?

Silver nanoparticles are added to the fibres used to make some socks. Silver has the special property that it can kill bacteria. As a result there are no unpleasant smells when wearing these socks.



Some scientists are concerned about the use of silver nanoparticles in socks.

The silver can be released from the socks when they are washed. This silver may end up in rivers. Silver in rivers may kill fish.

Scientists found that some makes of socks release the silver more easily than others. Socks in which the silver nanoparticles are trapped in the fibres released very little silver when washed.

By tfkrawksmysocks [CC BY-SA 2.0], via Flickr

(a) Suggest why silver stops unpleasant smells when wearing the socks.

.....

.....

(1)

(b) How is the size of silver nanoparticles different from normal sized silver particles?

.....

(1)

(c) The silver nanoparticles are more effective at preventing unpleasant smells than normal sized silver particles.

Suggest why.

.....

.....

(1)

(d) The silver nanoparticles should be trapped in the sock fibres.

Use the information in the article to explain why.

.....

.....

.....

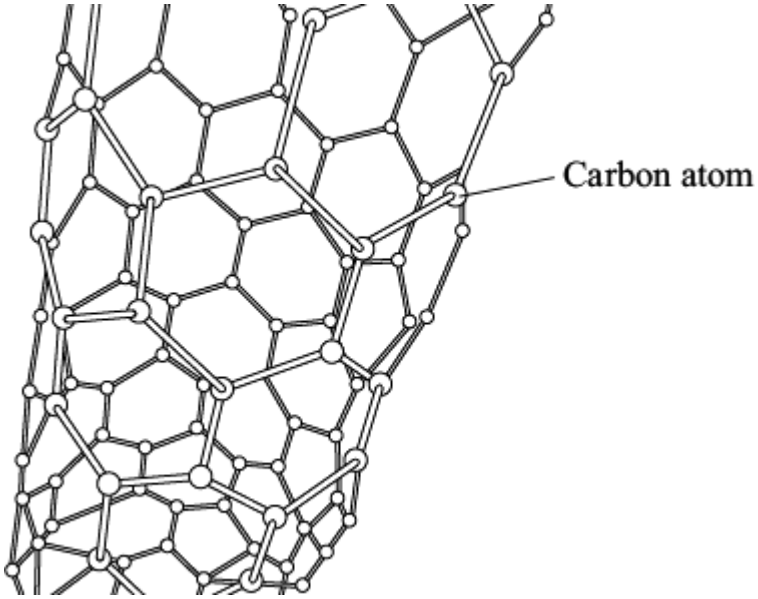
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(2)
(Total 5 marks)

Q10. Lightweight handlebars for bicycles are made from materials containing carbon nanotubes.

Carbon nanotubes are lightweight but very strong.

The diagram shows the structure of a carbon nanotube.



(a) What does the term 'nano' tell you about the diameter of carbon nanotubes?

Tick (✓) the correct answer in the table.

Answer	Tick (✓)
The diameter of the tube is very small.	
The diameter of the tube is large.	
The diameter of the tube is very large	

(1)

(b) Look at the diagram and then draw a ring around the correct word to complete each sentence.

(i) Carbon nanotubes are similar to graphite because each carbon atom is joined to

two
three
four

other carbon atoms.

(1)

(ii) The carbon atoms are joined by

covalent
ionic
metallic

bonds.

(1)

(iii) Carbon nanotubes are very strong because the

atoms
bonds
electrons

are hard to break.

(1)
(Total 4 marks)