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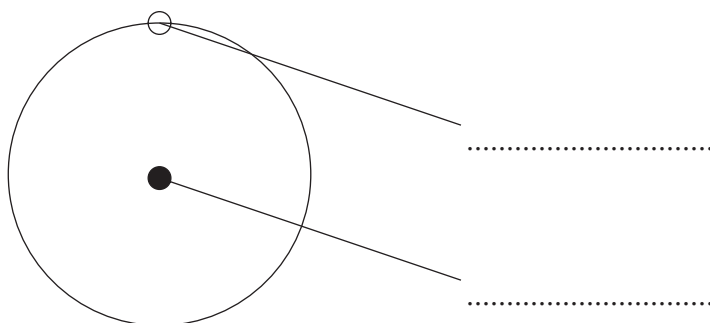
Answer **all** questions in the spaces provided.

1 Hydrogen is an element.

1 (a) The diagram shows the parts of a hydrogen atom.

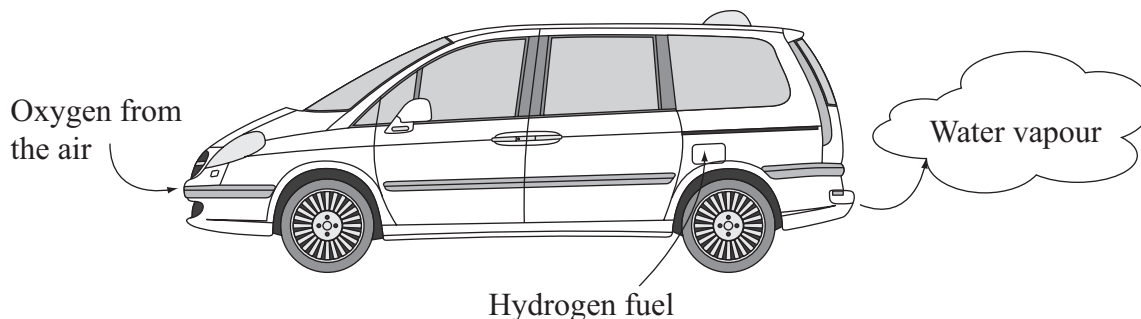
Use words from the box to label the diagram.

electron	group	nucleus	symbol
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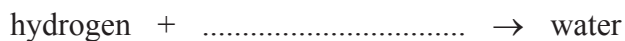
(2 marks)

1 (b) Hydrogen can be used as a *clean fuel* for cars.



1 (b) (i) When hydrogen burns in air, it reacts with another element.

Complete the word equation for this reaction.



(1 mark)

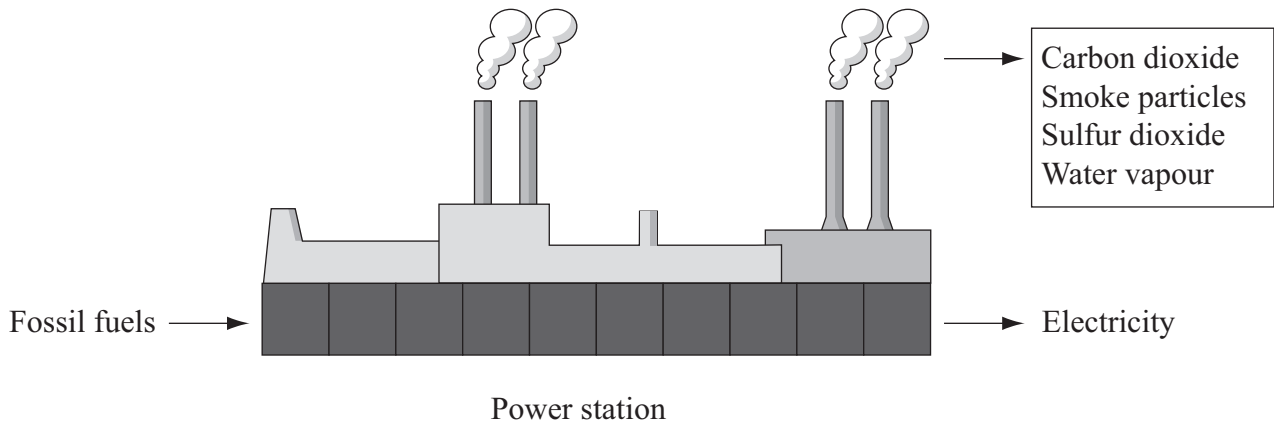
1 (b) (ii) Suggest **one** reason why hydrogen is called a *clean fuel*.

.....

(1 mark)

Turn over ►

- 2 Most electricity in the UK is generated in power stations that burn fossil fuels.
The diagram lists some of the substances released into the air when fossil fuels are burned.



- 2 (a) (i) Which **one** of the substances released into the air causes acid rain?

.....
(1 mark)

- 2 (a) (ii) In the sentence below, draw a ring around the correct answer.

The type of environmental pollution caused by

smoke particles is

- | |
|-------------------|
| global dimming |
| global warming |
| rising sea levels |

(1 mark)

- 2 (a) (iii) Suggest how the burning of fossil fuels may cause climate change.

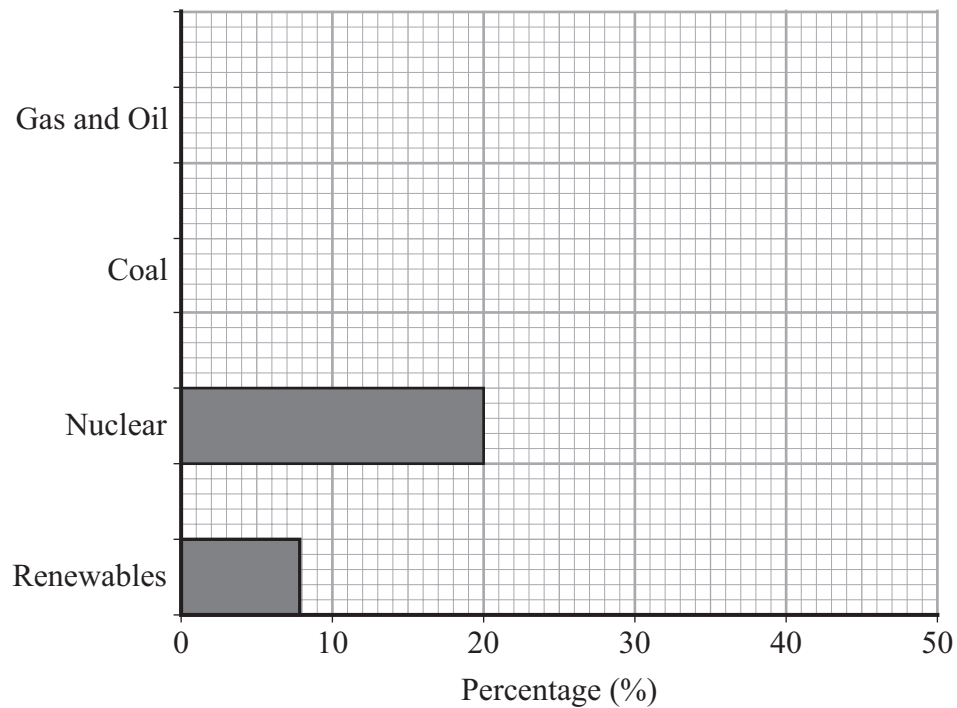
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(2 marks)

- 2 (b) The table shows the percentage of electricity generated by different energy sources.

Energy sources	Renewables	Nuclear	Coal	Gas and Oil
Percentage (%)	8	20	32	40

Complete the bar chart to show the percentage of electricity generated by coal and by gas and oil.



(2 marks)

6

Turn over for the next question

Turn over ►

3 A headline from 27 December 2004 read:

‘MASSIVE EARTHQUAKE CAUSES TSUNAMI’

The earthquake happened at a plate boundary under the sea. This produced a huge wave, called a tsunami. The wave travelled quickly across the Indian Ocean. The tsunami destroyed homes on many islands and on the east coast of India.

3 (a) Use words from the box to complete the sentences about earthquakes.

convection radioactive tectonic volcanic

The earthquake was caused by the movement of two of the Earth’s
..... plates.

The energy for this movement comes from the heat released by natural
..... processes.

(2 marks)

3 (b) It was estimated that 300 000 people died as a result of the tsunami in 2004.

Some newspapers criticised scientists for not predicting the tsunami, because if people had been warned they could have moved to safety.

3 (b) (i) Suggest why we can only estimate that 300 000 people died as a result of the tsunami.

.....
.....
.....
.....

(2 marks)

3 (b) (ii) Explain why scientists could not have predicted the tsunami.

.....
.....
.....
.....

(2 marks)

6

Turn over for the next question

Turn over ►

- 4 The label on a bottle of salad dressing shows that the dressing contains the following ingredients.

Ingredients	
Water	Extract of spices
Vegetable oil	Preservative E202
Egg yolk	Emulsifier E405
Sugar	
Flour	
Vinegar	
Salt	

- 4 (a) One of the main ingredients in salad dressing is vegetable oil.
- 4 (a) (i) Use the correct word from the box to complete the sentence about the extraction of vegetable oil.

crushed	evaporated	hardened
----------------	-------------------	-----------------

To extract the vegetable oil, the fruits or seeds of plants are first

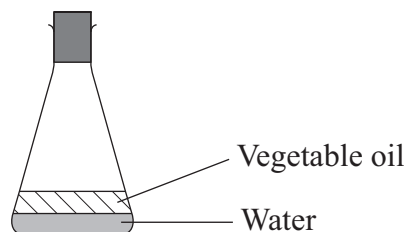
..... (1 mark)

- 4 (a) (ii) The liquids can be separated from the solid parts of the fruits or seeds by filtering. Suggest **one** reason why separation by filtering is better than separation by distilling.

.....

 (1 mark)

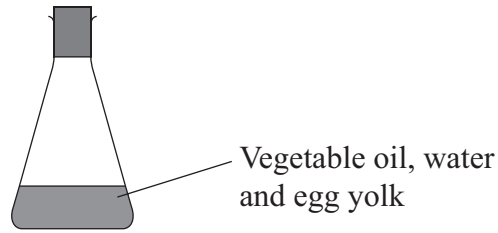
- 4 (b) (i) A mixture of vegetable oil and water is shaken and left to stand for several minutes. The diagram shows the result.



Complete the following sentence.

The vegetable oil and water (1 mark)

- 4 (b) (ii) A mixture of vegetable oil, water and egg yolk is shaken and left to stand for several minutes.
The diagram shows the result.



Use words from the box to complete the sentence.

additive distil emulsion extract mix separate

The egg yolk causes vegetable oil and water to
and form an

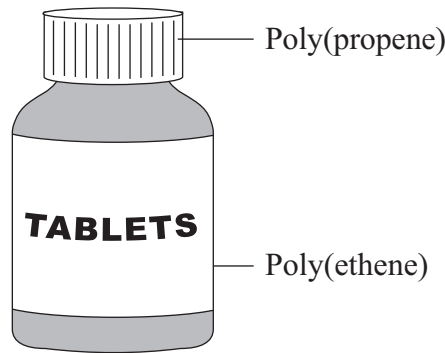
(2 marks)

5

Turn over for the next question

Turn over ▶

5 Tablet containers are often made from two different polymers.



5 (a) Ethene, C_2H_4 , and propene, C_3H_6 , can be made from crude oil.

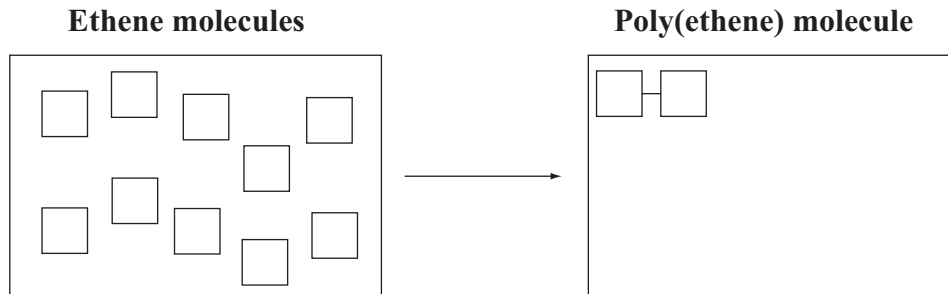
5 (a) (i) Complete the following sentence.

Ethene and propene are called hydrocarbons because they are made up of carbon and atoms only.

(1 mark)

5 (a) (ii) Ethene molecules are used to form poly(ethene) molecules.

Complete the diagram to show the poly(ethene) molecule.



(2 marks)

5 (b) The tablet containers could be disposed of in a landfill site or could be recycled.

5 (b) (i) Suggest **two** reasons why disposing of the tablet containers in a landfill site could cause problems.

1

.....

2

.....

(2 marks)

5 (b) (ii) Suggest **one** reason why recycling the tablet containers would be difficult.

.....

.....

(1 mark)

<hr/>
6

Turn over for the next question

Turn over ►

6 Metals and their alloys have many uses.

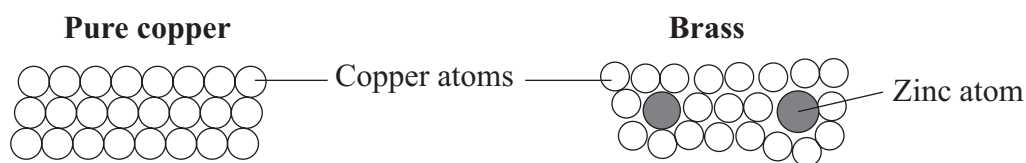
6 (a) Dentists use a smart alloy to make braces that gently push teeth into the right position.

What is meant by a *smart alloy*?

.....

(1 mark)

6 (b) Pure copper is made up of layers of copper atoms. Brass is an *alloy* of copper and zinc.

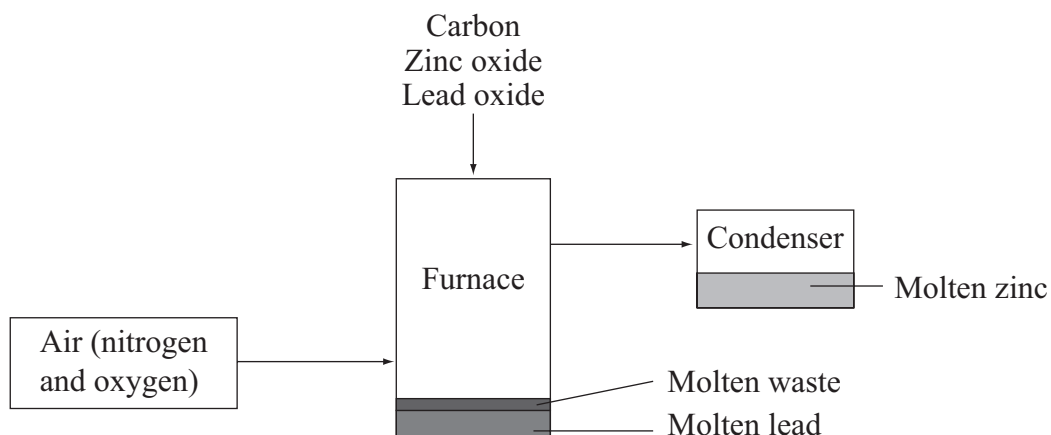


Why are the physical properties of brass different from the physical properties of pure copper?

.....

(2 marks)

6 (c) Nearly all zinc is obtained from ores that also contain lead. The metals zinc and lead can be extracted by reducing their oxides using carbon.



- 6 (c) (i) Choose **one** element from the box below to complete the sentence about the reduction of zinc oxide.

lead	nitrogen	oxygen
-------------	-----------------	---------------

Zinc oxide is reduced by carbon, which takes away.....
to leave zinc metal.

(1 mark)

- 6 (c) (ii) The melting points and boiling points of lead and zinc are given in the table.

Metal	Lead	Zinc
Melting point in °C	328	420
Boiling point in °C	1740	907

The furnace operates at a temperature of 1200°C.

Suggest how the lead metal and zinc metal are separated in the furnace.

.....

.....

.....

.....

(2 marks)

6

Turn over for the next question

Turn over ▶

7 Limestone is mainly calcium carbonate.

7 (a) Quicklime is produced by heating limestone.

7 (a) (i) Complete the word equation for this reaction by writing the chemical name of the solid and the gas produced.

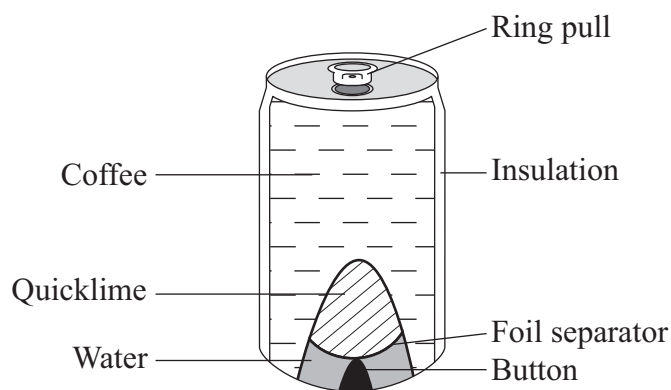
calcium carbonate → +
(2 marks)

7 (a) (ii) What is the name for this type of chemical reaction?

.....
(1 mark)

7 (b) Quicklime is used in self-heating cans.

The diagram shows a self-heating can designed to raise the temperature of coffee to 60°C.



The button on the base of the can is pushed. The foil separator breaks, allowing water to mix with the quicklime. After about 3 minutes, the can is opened by the ring pull. Insulating materials are used inside the walls of the can to prevent either the lips or the fingers from being burned.

7 (b) (i) Explain why the coffee becomes hot.

.....

 (2 marks)

7 (b) (ii) Suggest **two** reasons why it is **not** possible to re-use this self-heating can.

1

.....

2

.....

(2 marks)

7

Turn over for the next question

Turn over ►

8 The hydrocarbons in crude oil can be separated into useful fractions.

Fraction	Boiling point in °C	Carbon chain length	Relative % in crude oil	Relative % demand
Naphtha	20–180	5–9	10	20
Gasoline (petrol)	20–200	5–10	10	20
Kerosene (paraffin)	180–260	10–16	15	23
Diesel	260–340	14–20	20	25
Fuel oil	370–600	20–70	45	12

8 (a) Why does gasoline (petrol) have a lower boiling point than fuel oil?

.....

 (1 mark)

8 (b) Suggest why gasoline (petrol) costs more than fuel oil.

.....

 (2 marks)

8 (c) Describe how fuel oil can be changed into gasoline (petrol).

.....

 (2 marks)

5

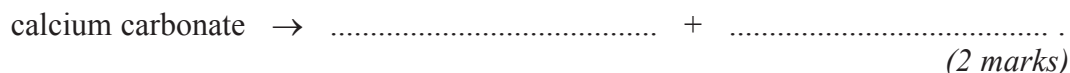
END OF QUESTIONS

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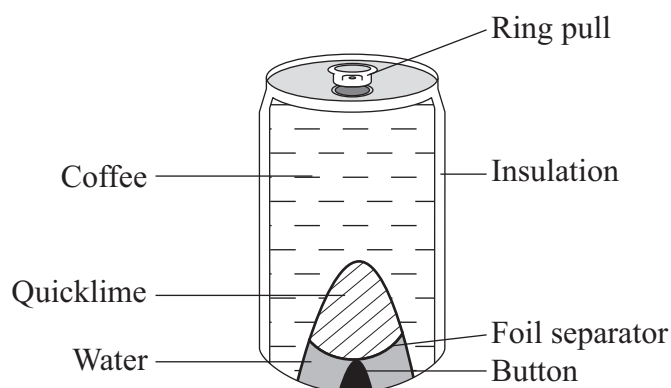


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(2 marks)

7

Turn over for the next question

Turn over ►

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2 (a) Why does gasoline (petrol) have a lower boiling point than fuel oil?

.....
.....
(1 mark)

2 (b) Suggest why gasoline (petrol) costs more than fuel oil.

.....
.....
.....
.....
(2 marks)

2 (c) Describe how fuel oil can be changed into gasoline (petrol).

.....
.....
.....
.....
(2 marks)

5

3

Why blue sweets are turning white

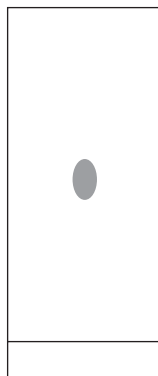
A recent study identified a possible harmful effect on children's nervous systems by some artificial colours. Two of these colours are Brilliant Blue (E133) and Quinoline Yellow (E104). Both are artificial colours because they are made from coal. The company is to stop producing the blue sweets because it is removing all artificial colours and there is no natural blue alternative.

- 3 (a) Suggest why it is important to be able to identify the colour additives in food.

.....

(1 mark)

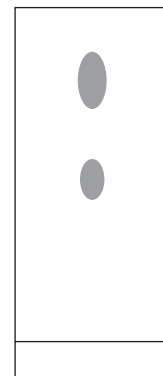
- 3 (b) A brown colour used in sweets was analysed using chromatography. The results were compared with those from E104 and E133.



E104



E133



Brown colour

What do the results tell you about the brown colour and its suitability for use in sweets?

.....

(3 marks)

- 3 (c) Once all the unsuitable colours are removed, the company claims that its sweets are now ‘free from artificial colours’.

Does this mean that the sweets contain no additives? Explain your answer.

.....

.....

.....

.....

(2 marks)

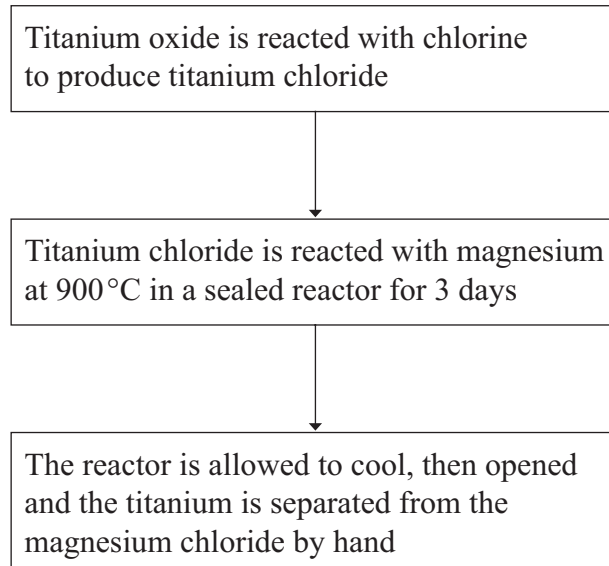
6

Turn over for the next question

Turn over ▶

- 4 Titanium is used in aircraft, ships and hip replacement joints. Titanium is as strong as steel but 45% lighter, and is more resistant to acids and alkalis.

Most titanium is produced from its ore, rutile (titanium oxide), by a batch process that takes up to 17 days.



Titanium reactors produce about 1 tonne of the metal per day.
Iron blast furnaces produce about 20 000 tonnes of the metal per hour.

- 4 (a) Give **one** property of titanium that makes it more useful than steel for hip replacement joints.

.....
(1 mark)

- 4 (b) In the reactor magnesium is used to produce titanium. If carbon were used instead of magnesium, no titanium would be produced.

What does this tell you about the relative reactivities of carbon, magnesium and titanium?

.....
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(2 marks)

4 (c) The use of titanium is limited because it is expensive.

Explain why titanium costs more than steel.

.....

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(3 marks)

6

Turn over for the next question

Turn over ►

5

Look after your heart

A diet high in polyunsaturated fat decreases the probability of developing coronary heart disease.
A diet high in saturated fat increases the probability of developing coronary heart disease.

5 (a)

Type of oil	Polyunsaturated fat in grams per 100 g of oil	Saturated fat in grams per 100 g of oil
Maize	49	16
Olive	11	14
Palm	8	45
Soya Bean	57	14

Use the information from the table above to answer each question.

5 (a) (i) Which type of oil appears to be best for your heart? Explain your answer.

.....

.....

.....

.....

(2 marks)

5 (a) (ii) Cultures that use only olive oil in food preparation have less heart disease than cultures that use other types of oil.

Suggest a possible reason for this.

.....

.....

(1 mark)

- 5 (b) A company compared the relative ‘unsaturation’ of five oils. Bromine water was added from a burette to equal amounts of each oil until the bromine water remained orange-yellow.

The volume added was recorded.

Type of oil	Volume of bromine water added in cm ³
Maize	25.6
Olive	6.1
Palm	4.9
Soya Bean	29.9
Sunflower	25.1

- 5 (b) (i) What would you see when the first few drops of bromine water are added to each oil?

.....
(1 mark)

- 5 (b) (ii) What do these results tell you about sunflower oil compared with the other oils?

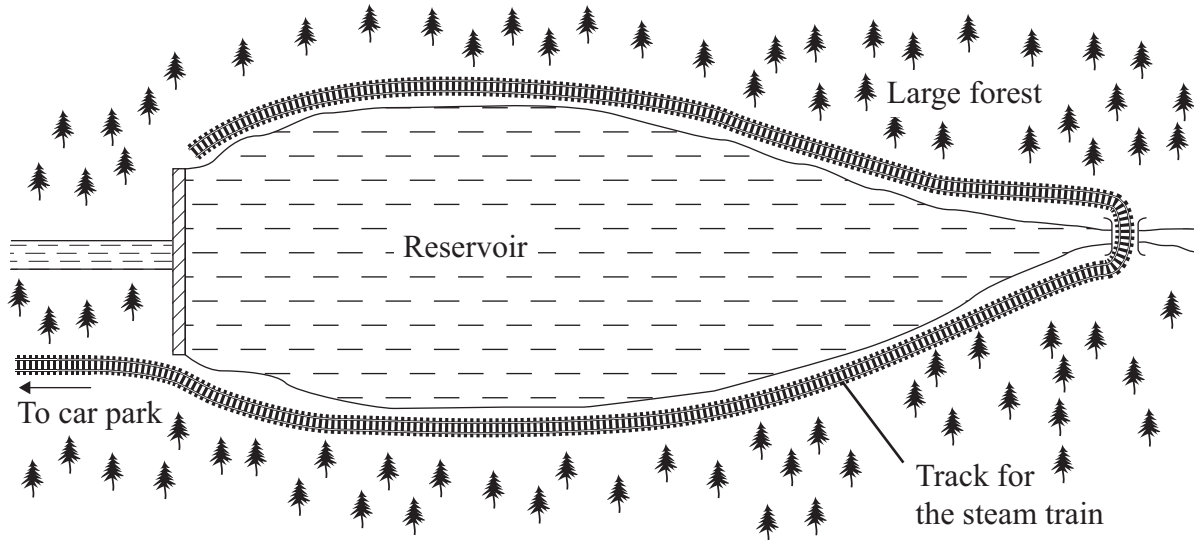
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(2 marks)

6

Turn over for the next question

Turn over ►

- 6 A large reservoir is surrounded by trees. Planners need to protect the environment. The distance around the reservoir is many kilometres. There will be only one road access to a car park a few kilometres from the reservoir. From the car park people would be transported to accommodation, activities or places of interest by steam train.



- 6 (a) Coal contains carbon and small amounts of sulfur. The steam train would cause environmental problems if coal were used as the fuel.

Explain why.

.....

.....

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(4 marks)

- 6 (b) The planners have stated that, as a result of using the steam train, there must be no overall increase of carbon dioxide added to the atmosphere. The steam train would be considered as ‘carbon neutral’ if wood, from the surrounding forest, were used as the fuel.

Suggest why.

.....

.....

.....

.....

.....

.....

.....

(3 marks)

7

Turn over for the next question

Turn over ▶

7 Scientists study the atmosphere on planets and moons in the Solar System to understand how the Earth’s atmosphere has changed.

7 (a) Millions of years ago the Earth’s atmosphere was probably just like that of Mars today.

The table shows data about the atmospheres of Mars and Earth as they are now.

Mars		Earth	
nitrogen	3 %	nitrogen	78 %
oxygen	trace	oxygen	21 %
water	trace	water	trace
carbon dioxide	95 %	carbon dioxide	trace
Average surface temperature -23°C		Average surface temperature 15°C	

Suggest what has caused the main gases in the Earth’s atmosphere of millions of years ago to change to the present-day atmosphere.

.....

.....

.....

.....

(2 marks)

7 (b) Titan is the largest moon of the planet Saturn. It has an atmosphere that, like the Earth’s, contains mainly nitrogen. Methane is the other main gas.

Main gases in Titan’s atmosphere	Percentage (%)	Boiling point in $^{\circ}\text{C}$
Nitrogen	95	-196
Methane	5	-164
Average surface temperature -178°C		

When it rains on Titan, it rains methane! Explain why.

.....

.....

.....

(2 marks)

7 (c) Ultraviolet radiation from the Sun produces simple alkenes, such as ethene and propene, from methane in Titan's atmosphere.

7 (c) (i) Draw the structure of propene, C_3H_6 , to show the covalent bonds.

(1 mark)

7 (c) (ii) Explain how propene molecules form a polymer. You should name the polymer formed.

.....

.....

.....

.....

.....

.....

(3 marks)

8

END OF QUESTIONS

(b) Complete these sentences by drawing a ring around the correct answer.

(i) Attempts to classify the elements into a periodic table were made

by

Arrhenius and Dalton
Brønsted and Lowry
Mendeleev and Newlands

(1 mark)

(ii) They arranged the elements in order of their

atomic weight
melting point
reactivity

(1 mark)

(iii) They put elements in the same Group if they had similar

boiling points
chemical reactions
electrical conductivities

(1 mark)

(iv) We now know that elements in the same Group have the same number of

electrons
neutrons
protons

in their outer shell (energy level).

(1 mark)

8

Turn over ►

- 2 A bottle of washing soda was found in a school laboratory. The modern name of washing soda is sodium carbonate.



A student tested the washing soda to prove that it was sodium carbonate.

- (a) The student did a flame test to show that washing soda is a sodium compound.

The student used a clean wire to put the washing soda into the flame.

- (i) Why should the wire be clean when used for a flame test?

.....
(1 mark)

- (ii) The table shows some properties of metals.

Two of these are properties that the wire must have if it is used for a flame test.

Put a tick (✓) next to the **two** correct properties.

Property	(✓)
Good electrical conductor	
High density	
High melting point	
Low boiling point	
Unreactive	

(2 marks)

- (iii) Which **one** of the following flame colours shows that washing soda is a sodium compound?

Draw a ring around your answer.

brick-red

lilac

yellow-orange

(1 mark)

- (b) The student used dilute hydrochloric acid to show that washing soda was a carbonate. Carbon dioxide gas was given off.

- (i) Describe what you **see** happening when a gas is given off.

.....
.....

(1 mark)

- (ii) The student used limewater to prove that the gas given off was carbon dioxide.

Complete this sentence by choosing the correct word from the box.

clear

colourless

milky

When carbon dioxide reacts with limewater, the limewater turns

.....
(1 mark)

- (c) Instrumental methods are used to identify chemicals.

Describe some advantages of instrumental methods compared with chemical tests by considering:

- the length of time needed to carry out a test
- the amount of chemical used.

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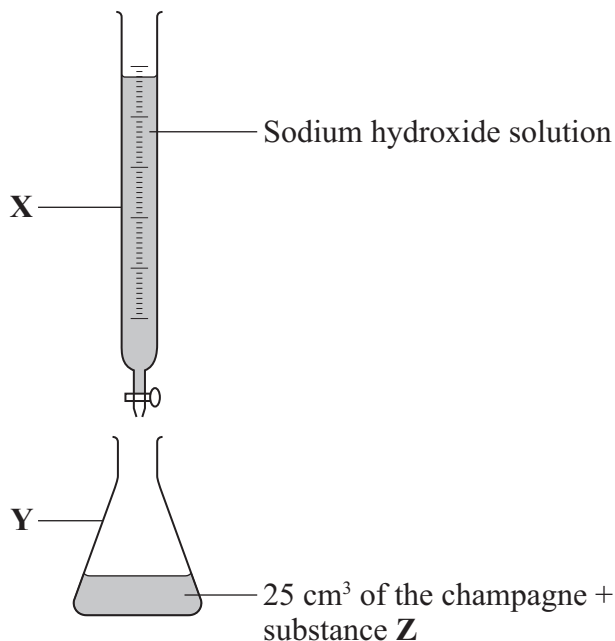
(2 marks)

8

Turn over ►

- 3 In 1916 a ship was sunk by a German submarine. The ship was carrying bottles of champagne. The wreck was discovered in 1997 and the champagne was brought to the surface and analysed.

The diagram shows the apparatus used to find the amount of acid in 25 cm³ of the champagne.



- (a) Choose the correct words from the box to name apparatus **X** and **Y**.

beaker	burette	conical flask	measuring cylinder
--------	---------	---------------	--------------------

- (i) Apparatus **X** is a
(1 mark)
- (ii) Apparatus **Y** is a
(1 mark)

- (b) Sodium hydroxide solution was added to this champagne until substance **Z** showed that the reaction was complete. The volume of sodium hydroxide used was recorded. The result was used to calculate the amount of acid present.

Complete these sentences by drawing a ring around the correct answer.

- (i) Substance **Z** is

a catalyst
a conductor
an indicator

(1 mark)

- (ii) The reaction was complete when substance **Z**

changed colour
formed a gas
gave a precipitate

(1 mark)

- (iii) The name of this method of analysis is

distillation
filtration
titration

(1 mark)

- (c) 250 cm³ of this champagne were found to contain 1 g of acid.

Calculate the mass of acid in 750 cm³ of this champagne.

.....
.....
.....

Mass = g
(2 marks)

Question 3 continues on the next page

Turn over ►

- (d) (i) Which **one** of the following ions makes champagne acidic?

Draw a ring around your answer.

chloride

hydrogen

sodium

(1 mark)

- (ii) The acid in champagne is a *weak* acid.

Complete this sentence by drawing a ring around the correct answer.

The word *weak* means that the acid

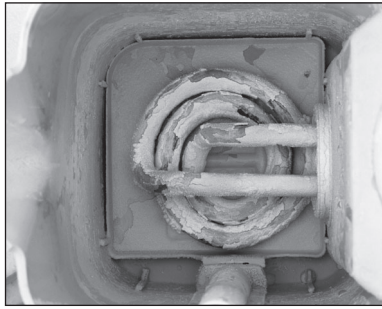
has a low boiling point

is dilute

is partially ionised

(1 mark)

4 Two problems of hard water are scale and scum, as shown in the pictures of a heating element and a wash basin.



(a) Name **one** ion that causes water to be hard.

.....
(1 mark)

(b) Hard water can be softened using an ion-exchange column.

Complete this sentence by choosing the correct word from the box.

aluminium	copper	sodium
------------------	---------------	---------------

When hard water passes through the column, the ions that cause hardness are exchanged for ions, and soft water is produced.
(1 mark)

(c) Describe how soap solution can be used to show that the water going into the column is hard **and** the water coming out is soft.

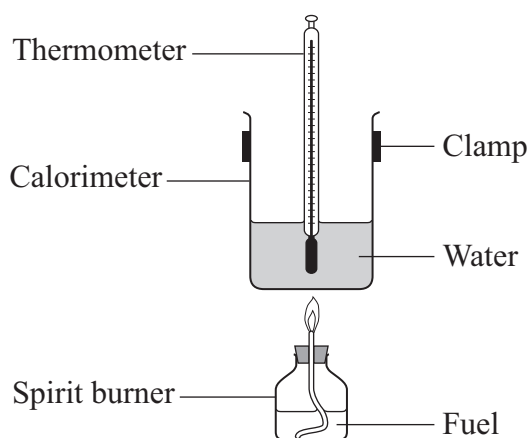
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.....
(3 marks)

5

Turn over ►

- 5 A student burned four fuels and compared the amounts of energy they produced.

The student set up the apparatus as shown in the diagram.



The heat produced when each fuel was burned was used to raise the temperature of 100 g of water. The student noted the mass of fuel burned, the increase in temperature and whether the flame was smoky.

The results are shown in the table.

Fuel	Mass of fuel burned (g)	Temperature increase ($^{\circ}\text{C}$)	Type of flame
Ethanol	4	24	Not smoky
Methanol	3	9	Not smoky
Peanut oil	2	20	Smoky
Vegetable oil	1	15	Smoky

- (a) The student suggested that the vegetable oil was the best fuel for producing heat.

Explain why.

.....

.....

.....

.....

(2 marks)

- (b) Suggest an environmental problem that could be caused when large amounts of vegetable oil are burned. Suggest how the problem could be overcome.

.....

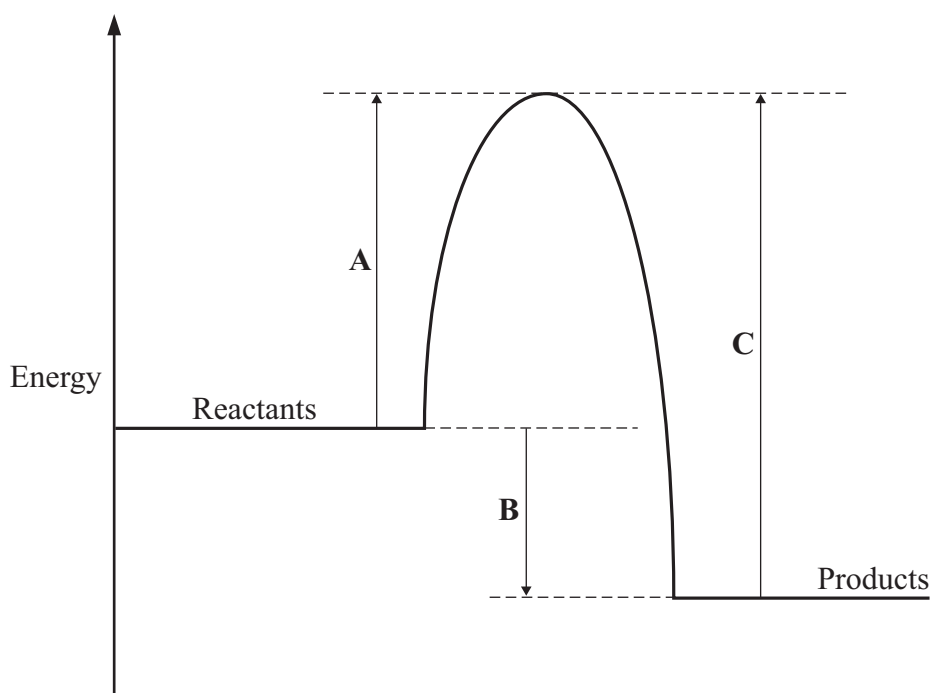
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.....

.....

(2 marks)

- (c) An energy level diagram for the burning of vegetable oil is shown below.



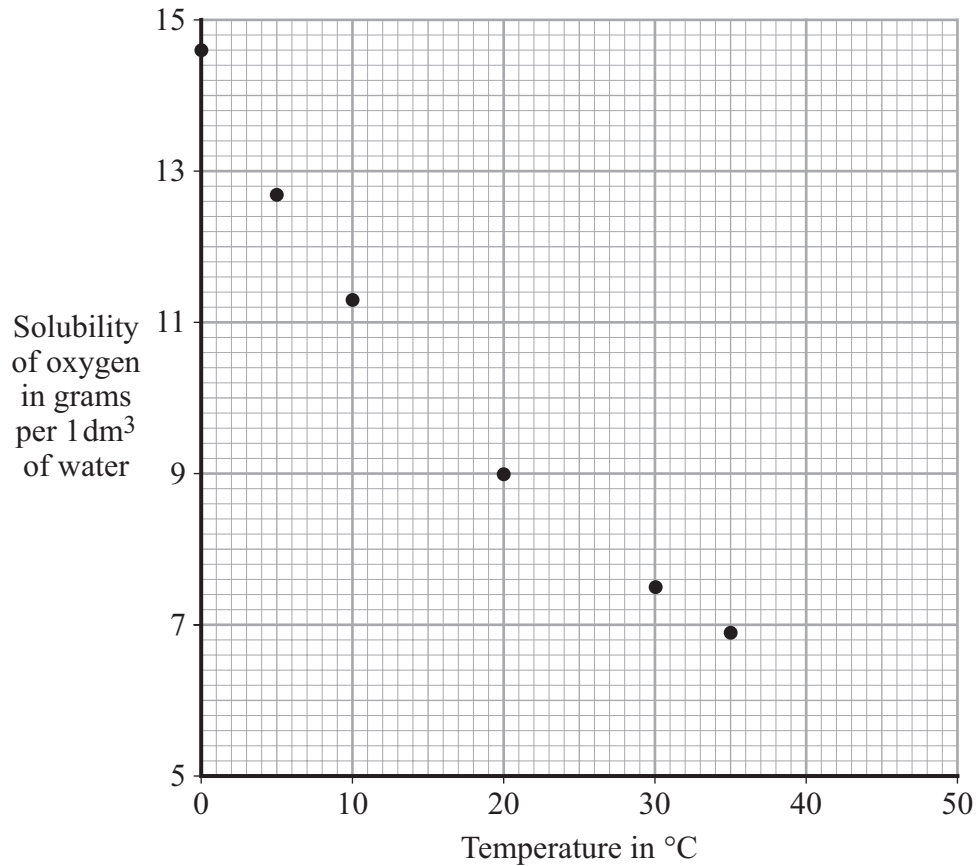
Which of the energy changes A, B or C:

- (i) represents the activation energy
(1 mark)
- (ii) shows the amount of energy given out during the reaction?
(1 mark)

6

Turn over ►

- 6 The points on the graph show the mass of oxygen that dissolves in 1 dm³ of water at different temperatures.



Use the graph to answer the following questions.

- (a) (i) Draw a smooth curve through the points, extending your curve to 50°C. *(1 mark)*
- (ii) Use your curve to estimate the mass of oxygen that dissolves in 1 dm³ of water at 50°C.

Mass = g
(1 mark)

- (iii) What mass of oxygen gas comes out of 1 dm³ of water when the temperature increases from 15 °C to 50 °C?

.....
.....

Mass = g
(2 marks)

- (iv) A student claimed that they were more sure of the value at 15 °C than the value at 50 °C.

Do you agree? Explain the reason for your answer.

.....
.....

(1 mark)

Question 6 continues on the next page

Turn over ►

- (b) Read the following information and then answer the questions.

Dissolved oxygen is essential for aquatic life. For example, trout need about 7 g/dm^3 of dissolved oxygen. They can live in concentrations down to about 5 g/dm^3 for short periods but are likely to die if the water temperature is above 26°C .

The amount of oxygen dissolved in water depends on many factors, including whether it is summer or winter, day or night. Factors such as photosynthesis and the action of wind add oxygen to water. Respiration of aquatic plants at night, decomposition of organic matter and higher temperatures remove oxygen.

The management of a factory wants to put small amounts of waste hot water at 50°C directly into a lake that contains trout. The local council has objected to this proposal and there is to be an Independent Public Enquiry.

- (i) Suggest why it is important to have an Independent Public Enquiry into adding hot water to this lake.

.....
.....
(1 mark)

- (ii) Suggest how the experience and status of the people giving evidence at the Public Enquiry could influence the final decision.

.....
.....
(1 mark)

- (iii) At the Public Enquiry, the factory management and the council gave their opinions. Suggest what these opinions were by completing the sentences.

The factory management said that there was **no** risk to the trout because

.....
.....

The council said that there **was** a risk to the trout because

.....
.....

(2 marks)

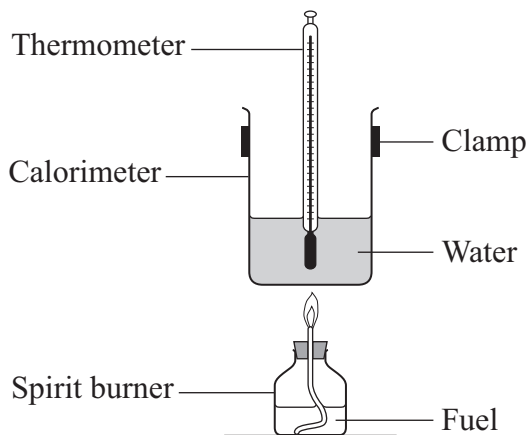
9

END OF QUESTIONS

Answer **all** questions in the spaces provided

1 A student burned four fuels and compared the amounts of energy they produced.

The student set up the apparatus as shown in the diagram.



The heat produced when each fuel was burned was used to raise the temperature of 100 g of water. The student noted the mass of fuel burned, the increase in temperature and whether the flame was smoky.

The results are shown in the table.

Fuel	Mass of fuel burned (g)	Temperature increase (°C)	Type of flame
Ethanol	4	24	Not smoky
Methanol	3	9	Not smoky
Peanut oil	2	20	Smoky
Vegetable oil	1	15	Smoky

(a) The student suggested that the vegetable oil was the best fuel for producing heat.

Explain why.

.....

.....

.....

.....

(2 marks)

- (b) Suggest an environmental problem that could be caused when large amounts of vegetable oil are burned. Suggest how the problem could be overcome.

.....

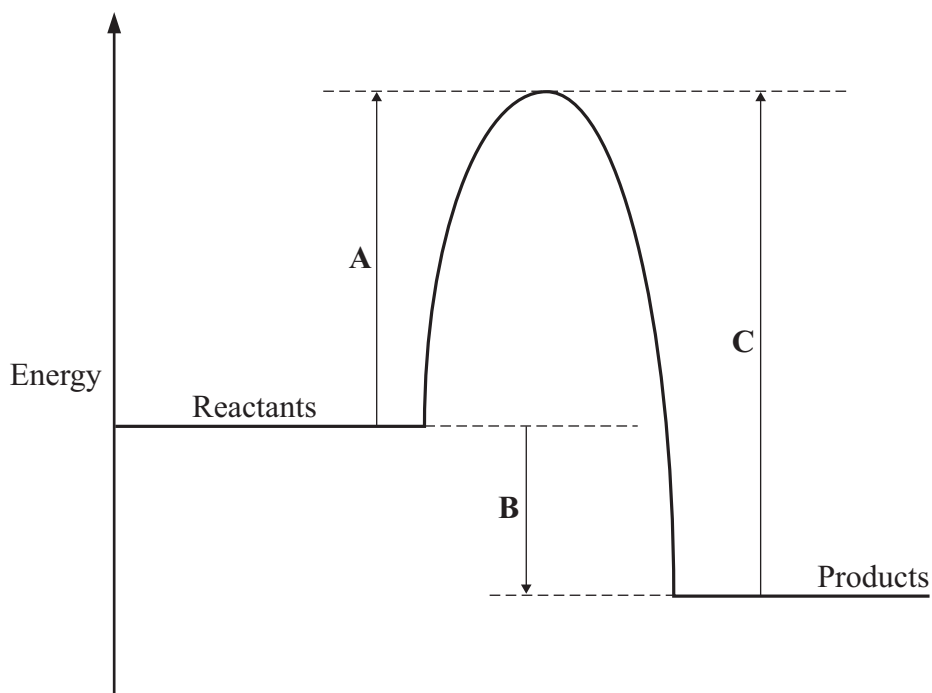
.....

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(2 marks)

- (c) An energy level diagram for the burning of vegetable oil is shown below.



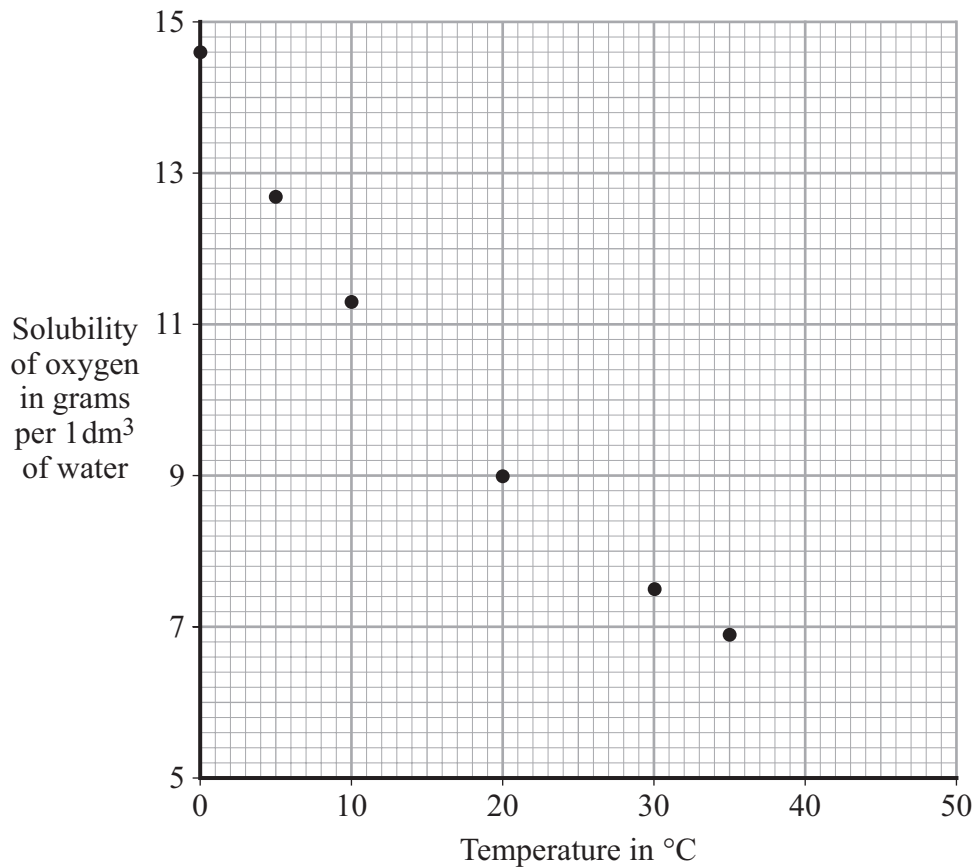
Which of the energy changes A, B or C:

- (i) represents the activation energy
(1 mark)
- (ii) shows the amount of energy given out during the reaction?
(1 mark)

6

Turn over ►

- 2 The points on the graph show the mass of oxygen that dissolves in 1 dm³ of water at different temperatures.



Use the graph to answer the following questions.

- (a) (i) Draw a smooth curve through the points, extending your curve to 50°C. (1 mark)
- (ii) Use your curve to estimate the mass of oxygen that dissolves in 1 dm³ of water at 50°C.

Mass = g
(1 mark)

- (iii) What mass of oxygen gas comes out of 1 dm³ of water when the temperature increases from 15 °C to 50 °C?

.....
.....

Mass = g
(2 marks)

- (iv) A student claimed that they were more sure of the value at 15 °C than the value at 50 °C.

Do you agree? Explain the reason for your answer.

.....
.....

(1 mark)

Question 2 continues on the next page

Turn over ►

- (b) Read the following information and then answer the questions.

Dissolved oxygen is essential for aquatic life. For example, trout need about 7 g/dm^3 of dissolved oxygen. They can live in concentrations down to about 5 g/dm^3 for short periods but are likely to die if the water temperature is above 26°C .

The amount of oxygen dissolved in water depends on many factors, including whether it is summer or winter, day or night. Factors such as photosynthesis and the action of wind add oxygen to water. Respiration of aquatic plants at night, decomposition of organic matter and higher temperatures remove oxygen.

The management of a factory wants to put small amounts of waste hot water at 50°C directly into a lake that contains trout. The local council has objected to this proposal and there is to be an Independent Public Enquiry.

- (i) Suggest why it is important to have an Independent Public Enquiry into adding hot water to this lake.

.....
.....
(1 mark)

- (ii) Suggest how the experience and status of the people giving evidence at the Public Enquiry could influence the final decision.

.....
.....
(1 mark)

- (iii) At the Public Enquiry, the factory management and the council gave their opinions. Suggest what these opinions were by completing the sentences.

The factory management said that there was **no** risk to the trout because

.....
.....
.....

The council said that there **was** a risk to the trout because

.....
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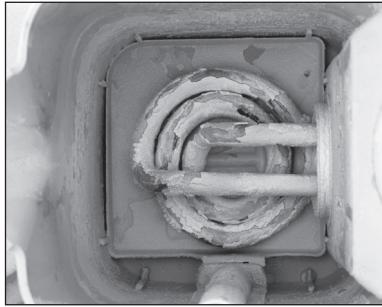
(2 marks)

9

Turn over for the next question

Turn over ►

3 Two problems of hard water are *scale* and *scum*, as shown in the pictures of a heating element and a wash basin.



(a) Explain the difference between *scale* and *scum*.

.....
.....
.....
.....

(2 marks)

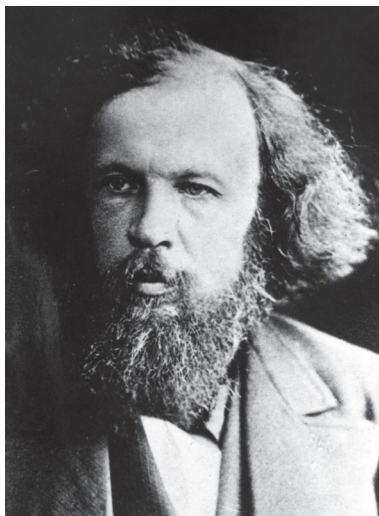
(b) Explain how hard water can be made soft using an ion-exchange column.

.....
.....
.....
.....

(2 marks)

4

4 Read the information about the periodic table.



When the Russian chemist Dimitri Mendeleev put forward his periodic table in 1869, the atomic structure of elements was unknown.

Mendeleev tried to arrange the elements in a meaningful way based on their chemical reactions. First he put the elements in order of their increasing atomic weight. He then put elements with similar properties in the same column.

However, he left gaps, and sometimes did not follow the order of increasing atomic weight – for example, he placed iodine (atomic weight 127) after tellurium (atomic weight 128).

Within a few years there was sufficient evidence to prove that Mendeleev was correct.

Our modern periodic table has evolved from Mendeleev’s table.

The modern periodic table on the Data Sheet may help you to answer these questions.

- (a) (i) State why Mendeleev left gaps.

.....
.....
(1 mark)

- (ii) State why some elements were **not** placed in order of increasing atomic weight.

.....
.....
(1 mark)

- (b) (i) The periodic table is now based on atomic structure.

Explain how.

.....

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(3 marks)

- (ii) Suggest why it is impossible to have an undiscovered element that would fit between sodium and magnesium.

.....

.....

(1 mark)

- (c) Explain, in terms of electrons, why fluorine is the most reactive element in Group 7.

.....

.....

.....

.....

.....

.....

.....

(3 marks)

9

Turn over ►

5 In 1916, during the First World War, a German U-boat sank a Swedish ship which was carrying a cargo of champagne. The wreck was discovered in 1997 and the champagne was brought to the surface and analysed.

(a) 25.0 cm³ of the champagne were placed in a conical flask.

Describe how the volume of sodium hydroxide solution needed to react completely with the weak acids in 25.0 cm³ of this champagne can be found by titration, using phenolphthalein indicator.

Name any other apparatus used.

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.....
.....
.....
.....
.....
.....

(4 marks)

(b) The acid in 25.0 cm³ of the champagne reacted completely with 13.5 cm³ of sodium hydroxide of concentration 0.10 moles per cubic decimetre.

Calculate the concentration in moles per cubic decimetre of acid in the champagne.

Assume that 1 mole of sodium hydroxide reacts completely with 1 mole of acid.

.....
.....
.....
.....

Concentration = moles per cubic decimetre
(2 marks)

- (c) Is analysis by titration enough to decide whether this champagne is safe to drink?

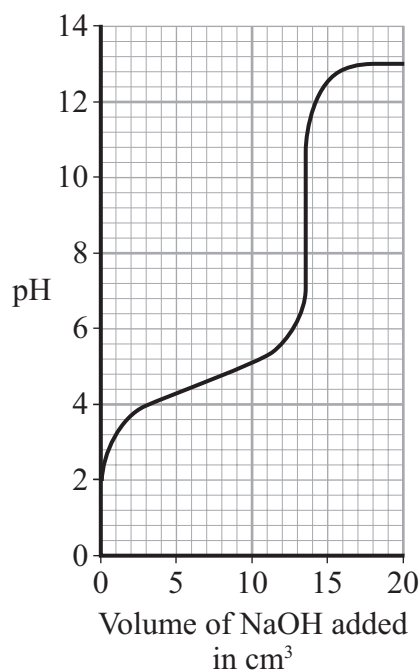
Explain your answer.

.....

.....

(1 mark)

- (d) The graph shows how the pH of the solution changes during this titration.



Phenolphthalein is the indicator used in this titration. It changes colour between pH 8.2 and pH 10.0.

Methyl orange is another indicator. It changes colour between pH 3.2 and pH 4.4.

Suggest why methyl orange is **not** a suitable indicator for this titration.

.....

.....

.....

.....

(2 marks)

9

Turn over ►

- 6 (a) Four bottles of chemicals made in the 1880s were found recently in a cupboard during a Health and Safety inspection at Lovell Laboratories.



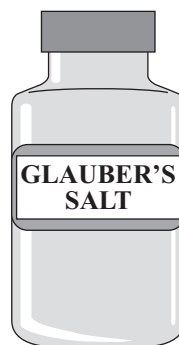
Sodium carbonate



Sodium chloride



Sodium nitrate



Sodium sulfate

The chemicals are correctly named.

You are provided with the following reagents:

- aluminium powder
- barium chloride solution acidified with dilute hydrochloric acid
- dilute hydrochloric acid
- silver nitrate solution acidified with dilute nitric acid
- sodium hydroxide solution.

- (i) Describe tests to show that these chemicals are correctly named.

In each case give the reagent(s) you would use and state what you would see.

Test and result for carbonate ions:

.....
.....

Test and result for chloride ions:

.....
.....

Test and result for nitrate ions:

.....
.....

Test and result for sulfate ions:

.....
.....

(5 marks)

- (ii) Suggest why a flame test would **not** distinguish between these four chemicals.

.....
(1 mark)

- (b) Instrumental methods of analysis linked to computers can be used to identify chemicals.

Describe **two** advantages of using instrumental methods of analysis.

.....
.....
.....
.....

(2 marks)

END OF QUESTIONS

8

1 Potassium sulfate and ammonium nitrate are both fertilisers.

Potassium sulfate has the formula K_2SO_4 .

Ammonium nitrate has the formula NH_4NO_3 .

Fertilisers contain one or more of the essential elements needed by plants.

(a) Ammonium nitrate contains the essential element nitrogen.

Potassium sulfate, K_2SO_4 , contains another one of these essential elements.

Which one?

..... [1]

(b) What is the total number of atoms shown in the formula K_2SO_4 ?

..... [1]

(c) Ammonium nitrate has a relative formula mass (M_r) of 80.

What is the relative formula mass of potassium sulfate, K_2SO_4 ?

The relative atomic mass of O is 16, of S is 32 and of K is 39.

.....
.....
.....

relative formula mass = [1]

2

(d) Potassium sulfate dissolves in water.

A **neutral** solution is made.

(i) What is the pH of potassium sulfate solution?

Choose from the list.

5

7

8

14

answer [1]

(ii) Why is it important that a fertiliser dissolves in water?

.....
..... [1]

(e) Clare makes ammonium nitrate.

She neutralises 25.0 cm³ of an alkali called ammonia.

She slowly adds an acid until the alkali is just neutralised.

(i) What is the name of the acid she must use?

Choose from the list.

hydrochloric acid

nitric acid

phosphoric acid

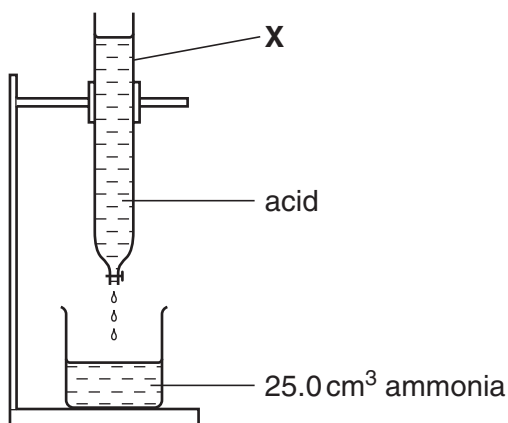
sulfuric acid

answer [1]

[Turn over for remainder of question 1

3

(ii) Look at the apparatus she uses.



What is the name of the apparatus labelled X?

..... [1]

(iii) Clare makes 0.45 g of ammonium nitrate.

She predicts she should make 0.50 g.

What is her percentage yield?

.....
.....
.....

percentage yield = % [2]

[Total: 9]

2 This question is about the manufacture of chemicals.

(a) Lots of ammonia is manufactured each year in the United Kingdom.

Ammonia is made by the reaction of nitrogen and hydrogen in a continuous process.

The conditions used for this reaction are

- 450 °C
- high pressure
- iron catalyst.

One of the costs of making ammonia is buying the raw materials.

Write about **two** other costs of making ammonia.

.....
.....
..... [2]

(b) A new anti-cancer drug is made from a rare plant only found in South America.

Less than 100 kg of the drug is made each year.

It is made in a batch process.

(i) What is the difference between a continuous process and a batch process?

.....
..... [1]

(ii) The cost of manufacturing and developing the drug is very high.

Write about some of the reasons why this cost is very high.

.....
.....
..... [2]

[Total: 5]

[Turn over

3 In the year 2006 many areas of the United Kingdom suffered drought conditions.

Water companies take water from rivers and store it in reservoirs.

Unfortunately in the year 2006 many rivers were almost dry.

Reservoirs were often less than half full.

(a) Look at the table.

It shows the annual rainfall in 1998 and 2001 for some regions of the United Kingdom.

region	rainfall in 1998 in mm	rainfall in 2001 in mm
Anglia	713	731
Northumbria	1039	807
North West	1435	1081
Severn Trent	885	767
Southern	875	865
South West	1428	1008
Thames	812	779
Wales	1642	1250
Wessex	1005	825
Yorkshire	964	787

(i) Which region had the **most** rainfall in the year 2001?

..... [1]

(ii) One region had **more** rainfall in the year 2001 than in 1998.

Which one?

..... [1]

(b) Rivers and reservoirs are two sources of drinking water.

Write down the name of one **other** source of drinking water in the United Kingdom.

..... [1]

(c) Water from rivers sometimes contains dangerous microbes.

These must be killed before the water is safe to drink.

How are these microbes killed when water is purified?

..... [1]

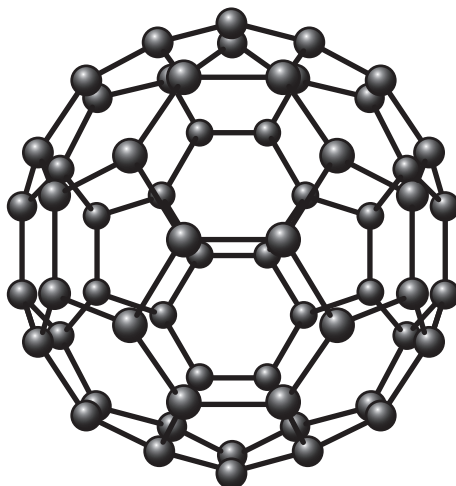
[Total: 4]

[Turn over

4 This question is about fullerenes and nanotubes.

(a) Look at the diagram of a fullerene.

It is called buckminster fullerene.



Buckminster fullerene is an element.

Which element?

..... [1]

(b) Fullerenes can be joined together to make nanotubes.

Nanotubes are used to make semiconductors and to reinforce graphite in sports equipment.

Put a tick (✓) in the box next to a correct property of nanotubes.

- electrical insulator
- soluble in water
- strong
- very low melting point

[1]

[Total: 2]

5 Ammonium sulfate and ammonium nitrate are both fertilisers.

Ammonium sulfate has the formula $(\text{NH}_4)_2\text{SO}_4$.

Ammonium nitrate has the formula NH_4NO_3 .

(a) What is the total number of **atoms** shown in the formula $(\text{NH}_4)_2\text{SO}_4$?

..... [1]

(b) Ammonium nitrate has a relative formula mass (M_r) of 80.

What is the relative formula mass of ammonium sulfate?

The relative atomic mass of H is 1, of N is 14, of O is 16, and of S is 32.

.....
.....
.....

relative formula mass = [1]

Ammonium nitrate contains 35% by mass of nitrogen.

What is the percentage by mass of nitrogen in ammonium sulfate?

.....
.....

percentage by mass = [1]

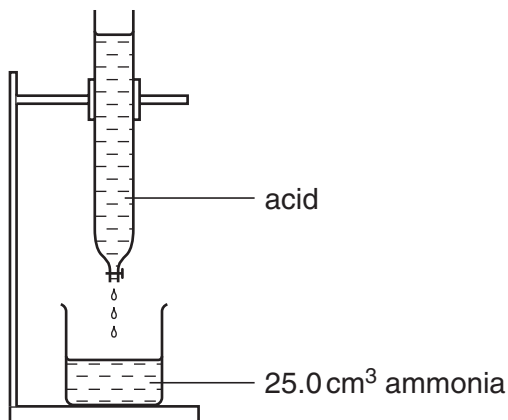
(c) Ammonium sulfate dissolves in water.

Why is it important that a fertiliser dissolves in water?

.....
..... [1]

(d) Clare makes ammonium nitrate.

Look at the apparatus she uses.



She uses 25.0 cm³ of an alkali called ammonia.

She slowly adds an acid until the alkali is just neutralised.

(i) What is the name of the acid she must use?

Choose from the list.

hydrochloric acid

nitric acid

phosphoric acid

sulfuric acid

answer..... [1]

(ii) The pH value in the beaker changes as the acid is added.

Describe how the pH value changes.

.....

Explain why.

.....

.....

..... [2]

[Turn over for remainder of question 1

10

(iii) Clare makes 0.45 g of ammonium nitrate.

She predicts she should make 0.50 g.

What is her percentage yield?

.....
.....
.....

percentage yield = % [2]

[Total: 9]

6 This question is about the manufacture of chemicals.

(a) Many millions of tonnes of ammonia are manufactured each year in the United Kingdom.

Ammonia is made by the reaction of nitrogen and hydrogen in a continuous process.

The conditions used for this reaction are

- 450 °C
- high pressure
- iron catalyst.

Explain why these conditions are chosen.

Use ideas about rate of reaction and percentage yield in your answer.

.....
.....
.....
.....
..... [3]

(b) A new anti-cancer drug is made from a rare plant only found in South America.

Less than 100 kg of the drug is made each year.

It is made in a batch process.

The cost of manufacturing and developing the drug is very high.

Write about some of the reasons why this cost is very high.

.....
.....
..... [2]

(c) The anti-cancer drug is made in a batch process rather than a continuous one.

Suggest one reason why.

.....
..... [1]

[Total: 6]

[Turn over

7 Washing up liquids contain a detergent.

Washing up liquid will clean plates covered in fat.

(a) Look at the diagram of a detergent molecule.

Label the diagram to show

- the hydrophilic part of the molecule
- the hydrophobic part of the molecule.



[1]

(b) Detergent molecules help to remove fat from a dirty plate.

Explain how.

A labelled diagram will help you to answer this question.

.....

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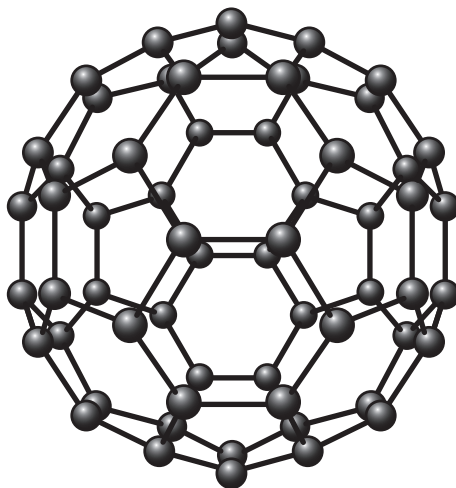
..... [2]

[Total: 3]

8 This question is about fullerenes and nanotubes.

(a) Look at the diagram of a fullerene.

It is called buckminster fullerene.



What is the chemical formula of buckminster fullerene?

..... [1]

(b) Fullerenes can be joined together to make nanotubes.

Nanotubes are used to make very effective industrial catalysts.

Give **one** reason why.

..... [1]

[Total: 2]

[Turn over