AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.3.1.1

Conservation of mass and balanced chemical equations

Past-paper questions

Tier	**Higher**
Question groups	**70**
Available paper years	**2007–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.3.1.1 Conservation of mass and balanced chemical equations

Question 01

January 2007 | CHY1H | Original Q3 | Legacy

3 Many everyday items are made from iron.

(a) Haematite is an *ore* of iron. Haematite contains iron oxide, Fe_2O_3.

(i) What is the meaning of the term *ore*?

.....

.....

(1 mark)

(ii) Iron can be produced by reacting iron oxide with carbon in a blast furnace.

What type of reaction produces the iron?

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(1 mark)

(iii) The word equation for this reaction is:

iron oxide + carbon → iron + carbon dioxide

Complete and balance the symbol equation for this reaction.

.....Fe_2O_3 + ...C → ..... + ...

(2 marks)

Question 3 continues on the next page

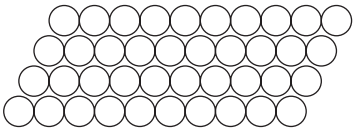
4.3.1.1 Conservation of mass and balanced chemical equations

Question 01 · continued

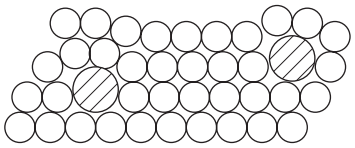
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(b) Pure iron is relatively soft and not very strong.

The iron from the blast furnace is very hard and brittle. It contains about 4 % carbon and is used as cast iron.



Pure iron



Cast iron

Explain the differences in the properties of pure iron and cast iron by referring to the diagrams.

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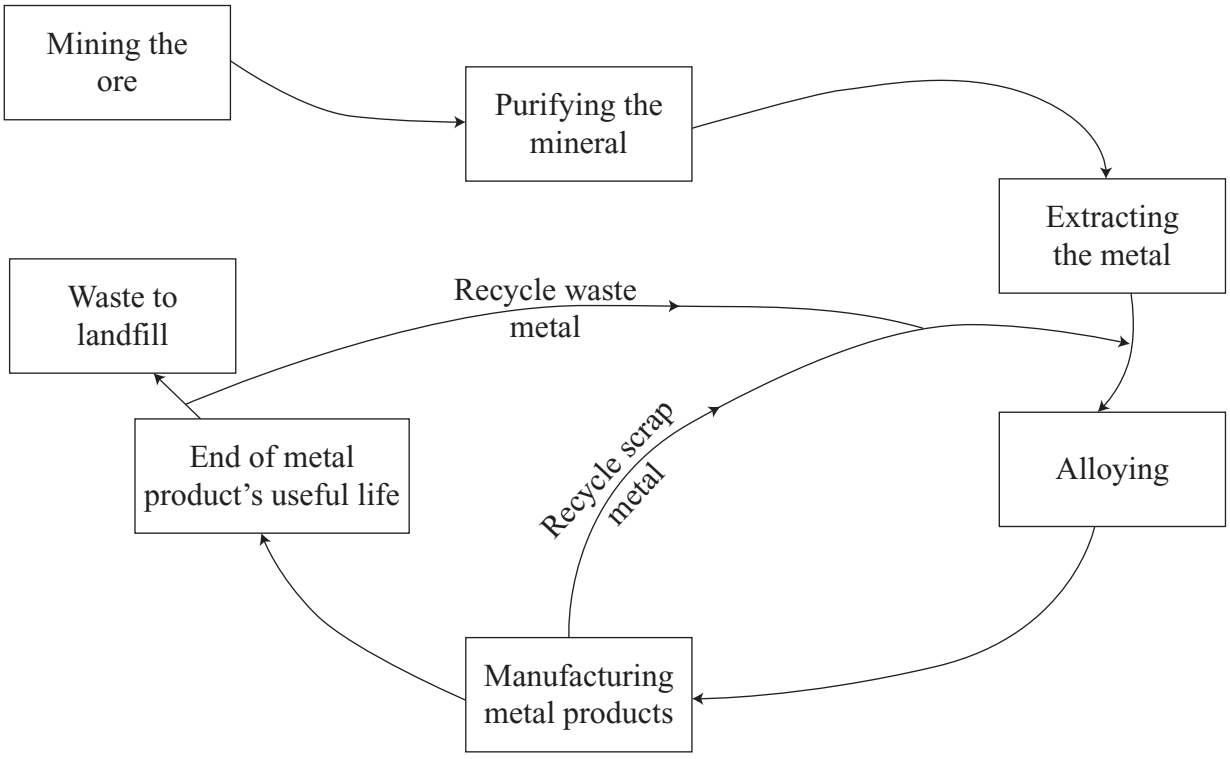
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4.3.1.1 Conservation of mass and balanced chemical equations

Question 01 · continued

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(c) The diagram shows the way in which iron is extracted, used and recycled.



Explain why the recycling of iron is necessary for sustainable development.

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(3 marks)

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4.3.1.1 Conservation of mass and balanced chemical equations

Question 02

June 2007 | CHY1A | Original Q8 | Legacy

QUESTION EIGHT

Exhaust fumes from petrol-driven cars contain harmful gases, particularly acidic nitrogen oxide, poisonous carbon monoxide and unburned hydrocarbons.

Catalytic converters are fitted to these cars to help to reduce the quantities of these gases released into the atmosphere. The reaction in the converter can be summarised by this equation:

carbon monoxide + nitrogen oxide → carbon dioxide + nitrogen

The catalysts in the converters usually contain a mixture of two transition metals, platinum and rhodium.

These metals occur in the Earth's crust mainly with copper and nickel sulfide ores.
To extract the metals, the ores are roasted in air which produces sulfur dioxide.

8A The balanced, symbol equation for the reaction between carbon monoxide and nitrogen oxide is . . .

1 $2CO + 2NO \rightarrow 2CO_2 + N_2$

2 $CO + NO \rightarrow CO_2 + N_2$

3 $2CO + 2NO \rightarrow CO_2 + N_2$

4 $2CO + 2NO \rightarrow CO_2 + 2N_2$

8B Which substance is reduced in this reaction?

1 carbon monoxide

2 carbon dioxide

3 nitrogen oxide

4 nitrogen

8C Why do some environmental organisations question the benefits of catalytic converters?

1 They are expensive to manufacture and make cars more expensive.

2 Polluting gases are released both in producing them and in using them.

3 They do not remove any of the harmful gases from the exhaust fumes.

4 Nitrogen is a poisonous gas.

4.3.1.1 Conservation of mass and balanced chemical equations

8D What conclusion about the use of catalytic converters can safely be made from the information in this question?

1 Transition metals are good conductors of heat and electricity.

2 There are no harmful gases in the exhaust fumes from a car fitted with a catalytic converter.

3 A catalytic converter reduces the amount of carbon monoxide in the exhaust fumes from a petrol-driven car.

4 Catalytic converters work equally well in both diesel-driven and petrol-driven cars.

Turn over for the next question

4.3.1.1 Conservation of mass and balanced chemical equations

Question 03

2 Copper is a widely used metal. The main ore of copper contains copper sulfide. Copper can be extracted from copper sulfide in a three stage process.

(a) In the first stage of extraction the copper sulfide is heated in air.

(i) Balance the symbol equation for the reaction.

$$Cu_2S + ...O_2 \rightarrow .....CuO + SO_2$$

(1 mark)

(ii) Explain why there would be an environmental problem if the gas from this reaction were allowed to escape into the atmosphere.

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(2 marks)

(b) In the second stage copper oxide, CuO, is reduced using carbon.

Describe and explain what happens during this reaction.

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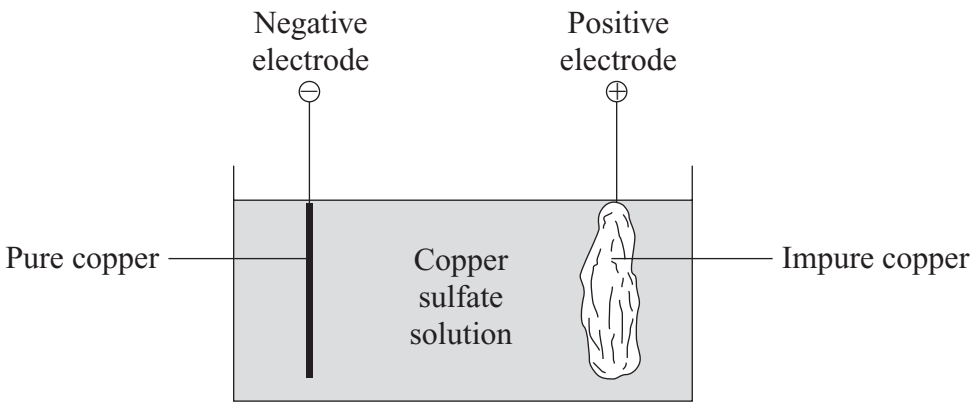
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4.3.1.1 Conservation of mass and balanced chemical equations

Question 03 · continued

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(c) During the third stage the copper can be purified as shown in the diagram.



(i) What is the name of the type of process used for this purification?

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(1 mark)

(ii) Give **one** use of purified copper.

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(1 mark)

(d) Copper-rich ores are running out.

New ways of extracting copper from low grade ores are being researched.

Recycling of copper may be better than extracting copper from its ores.

Explain why.

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(3 marks)

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4.3.1.1 Conservation of mass and balanced chemical equations

Question 04

June 2007 | CHY1H | Original Q5 | Legacy

5 Known crude oil reserves are being used up rapidly. Crude oil is used to produce many useful fuels, such as petrol. One way to conserve crude oil reserves would be to increase the production of bio-fuels.

(a) Ethanol can be produced for use as a bio-fuel. Cars can be powered by ethanol or ethanol–petrol mixtures.

Sugar cane can be fermented to give a mixture of water (boiling point 100 °C) and ethanol (boiling point 78 °C).

(i) How can ethanol be separated from water?

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.....

(1 mark)

(ii) Ethanol, C_2H_5OH, burns to release heat energy.

Complete the balanced symbol equation by writing in the formulae of the two products.

$C_2H_5OH + 3O_2 \rightarrow 2..... + 3.....$

(2 marks)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 04 · continued

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(b) The cost of producing a bio-fuel, such as ethanol, by fermentation, is at least three times higher than the production cost of petrol. It costs less to produce ethanol from alkanes. In the production, the vapour of an alkane is passed over a hot catalyst.

$$\underset{\text{hexane}}{C_6H_{14}} \xrightarrow{\text{Hot catalyst}} \underset{\text{ethane}}{C_2H_6} + \underset{\text{ethene}}{2C_2H_4}$$

Ethene is then converted into ethanol.

(i) What has happened to the hexane to produce ethene?

.....

(1 mark)

(ii) Complete the structural formula for ethene, C_2H_4.

C **C**

(1 mark)

(iii) Name the compound that is added to ethene to produce ethanol, C_2H_5OH.

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(1 mark)

(c) As explained in parts (a) and (b), ethanol can be made using either sugar or alkanes as the starting material.

Evaluate the advantages and disadvantages of using these two starting materials to produce ethanol.

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(4 marks)

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4.3.1.1 Conservation of mass and balanced chemical equations

Question 05

November 2007 | CHY1A | Original Q6 | Legacy

QUESTION SIX

The diagram shows part of the periodic table.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
	Be						
Na	Mg	Al	Si	P	S	Cl	Ar
	Ca						
	Sr						

The row of substances from sodium (Na) to argon (Ar) is called a period.

6A Magnesium (Mg) and calcium (Ca) are placed in the same group of the periodic table because they . . .

1 have a similar colour.

2 have similar boiling points.

3 have similar chemical properties.

4 are next to each other in the reactivity series.

6B Magnesium (Mg) and sulfur (S) are in the same period.

Which row in the table below correctly shows one similarity and one difference between magnesium and sulfur?

	Similarity	Difference
1	Both are solids.	Magnesium is a non-metal; sulfur is a metal.
2	Both conduct electricity.	Magnesium is a solid; sulfur is a gas.
3	Both are solids.	Magnesium conducts electricity; sulfur does not.
4	Both conduct electricity.	Magnesium is a metal; sulfur is a non-metal.

4.3.1.1 Conservation of mass and balanced chemical equations

Question 05 · continued

6C Calcium (Ca) is in the periodic table but quicklime is not.

This is because . . .

1 calcium is a metal but quicklime is a non-metal.

2 calcium is an element but quicklime is a compound.

3 calcium is an element but quicklime is an alloy.

4 calcium is a metal but quicklime is a carbonate.

6D The balanced equation which shows the reaction between sodium and chlorine is . . .

1 $Na + Cl_2 \rightarrow NaCl_2$

2 $2Na + Cl_2 \rightarrow Na_2Cl_2$

3 $2Na + Cl_2 \rightarrow 2NaCl$

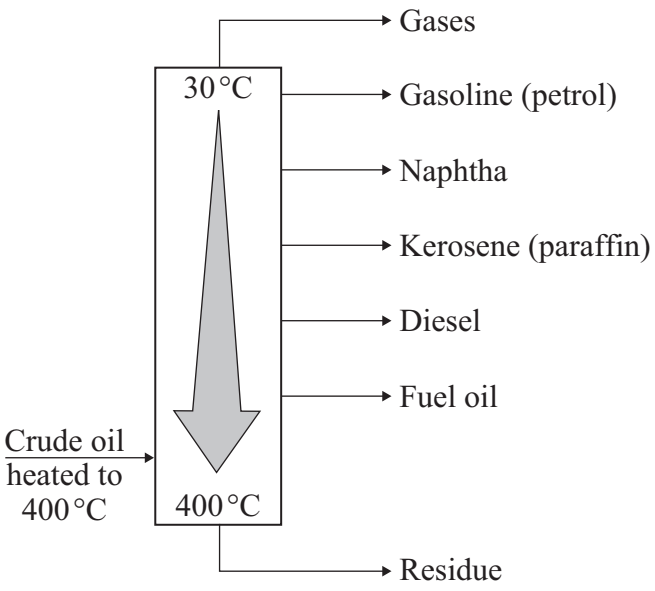
4 $2Na + 2Cl_2 \rightarrow 2NaCl_2$

4.3.1.1 Conservation of mass and balanced chemical equations

Question 06

January 2008 | CHY1H | Original Q6 | Legacy

6 Crude oil is the source of many useful materials. Crude oil is separated into fractions by fractional distillation.



(a) Describe how the naphtha fraction separates from the other fractions.

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(2 marks)

(b) The naphtha fraction is often used to make other useful materials.
This involves the cracking of hydrocarbons in the naphtha fraction.

For example:

decane → hexane + ethene

$C_{10}H_{22} \rightarrow C_6H_{14} + C_2H_4$

(i) Balance the symbol equation given above.

(1 mark)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 06 · continued

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(ii) Describe how cracking is carried out.

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(2 marks)

(iii) Why does ethene have different chemical properties from decane and hexane?

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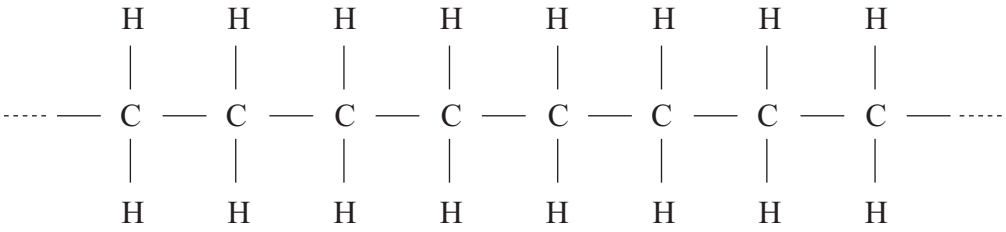
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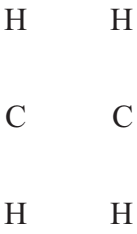
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(2 marks)

(c) Ethene is used as the starting material for many polymers. The most common polymer is poly(ethene). One hydrocarbon molecule in poly(ethene) will contain thousands of carbon atoms.



Complete the diagram to show the bonds in ethene.



(1 mark)

Question 6 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

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(d) Read the following information.

Landfill, Incineration, Recycling and Re-use of Poly(ethene)

People could be encouraged to re-use their poly(ethene) bags and containers.

Recycling poly(ethene) saves raw materials and energy needed to make new plastic. When polymers are recycled the plastics must be collected, transported, sorted into different types by hand and washed. This requires the use of fossil fuels and is expensive.

Poly(ethene) can be burnt in an incinerator with other household waste. The heat released could be used to make steam to drive an electric generator. Surplus heat could be used to heat greenhouses used for growing vegetables. Incineration at too low a temperature can produce harmful substances. The residue (ash) has to go to landfill.

Landfill is probably the easiest way to dispose of polymers and it is cheap. Polymers are often mixed in with other household rubbish. Household waste does not get sorted into different materials because it is disposed of in the same hole in the ground. When the hole is eventually full, the waste is covered by a layer of soil to stop it smelling. The waste gets compressed under its own weight. Most polymers, such as poly(ethene), are not biodegradable so will remain in the ground forever.

4.3.1.1 Conservation of mass and balanced chemical equations

Question 06 · continued

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You are asked to decide which option for the disposal of poly(ethene) will be put forward in your area. You decide that recycling is the best option.

Suggest **one** economic argument and **one** environmental argument that will be made against recycling.

For each argument made, how will you persuade those making the argument to accept your option?
(You must use only one sentence for each argument made against your decision and only one sentence for your response to it.)

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(4 marks)

12

4.3.1.1 Conservation of mass and balanced chemical equations

Question 07

January 2008 | CHY2H | Original Q5 | Legacy

5 Distress flares are used to attract attention in an emergency.



Flares often contain the element magnesium. Magnesium burns to form magnesium oxide.

(a) The distress flare burns with a bright flame because the reaction is very *exothermic*.

State the meaning of *exothermic*.

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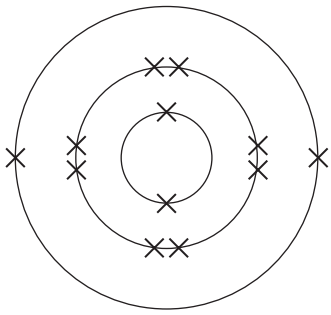
(1 mark)

(b) Write a balanced symbol equation for the reaction between magnesium (Mg) and oxygen (O_2) to form magnesium oxide (MgO).

.....

(1 mark)

(c) The diagram shows the electronic structure of a magnesium atom.
The atomic (proton) number of magnesium is 12.



Magnesium atom

Draw a similar diagram to show the electronic structure of an oxygen atom.
The atomic (proton) number of oxygen is 8.

(1 mark)

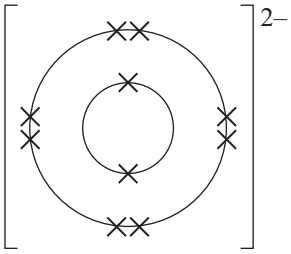
4.3.1.1 Conservation of mass and balanced chemical equations

Question 07 · continued

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(d) Magnesium ions and oxide ions are formed when magnesium reacts with oxygen.

The diagram shows the electronic structure of an oxide ion.



Oxide ion

Draw a similar diagram to show the electronic structure of a magnesium ion.

(1 mark)

(e) Magnesium oxide is a white solid with a high melting point.

Explain how the ions are held together in solid magnesium oxide.

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(2 marks)

(f) Indigestion tablets can be made from magnesium oxide. The magnesium oxide neutralises some of the hydrochloric acid in the stomach.

Complete the word equation for the reaction between magnesium oxide and hydrochloric acid.

hydrochloric acid + magnesium oxide → ..... + water.

(1 mark)

7

4.3.1.1 Conservation of mass and balanced chemical equations

Question 08

June 2008 | CHY2H | Original Q3 | Legacy

3 Copper sulfate ($CuSO_4$) is a salt that has many uses.

An aqueous solution of copper sulfate can be made by reacting copper oxide (CuO) with an acid.

3 (a) (i) Name this acid. .....

(1 mark)

3 (a) (ii) Write a balanced symbol equation, including state symbols, for this reaction.

.....

(2 marks)

3 (b) Copper oxide reacts much faster with acid at 40 °C than at 20 °C.

Explain why in terms of particles.

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(2 marks)

5

4.3.1.1 Conservation of mass and balanced chemical equations

Question 09

June 2008 | CHY3H | Original Q4 | Legacy

4 The following article appeared recently in the *Manchester Gazette*.

> **Sodium Drum Blaze Scare**
>
> A 20 litre drum containing sodium burst into flames when it reacted violently with rainwater at a Manchester factory. It is believed that the sodium, which is normally stored under oil, had been accidentally left outside with the lid off.
>
> A factory worker put out the blaze before the fire services arrived, and a leading fire fighter said, "It was fortunate that potassium wasn't involved as it would have reacted more violently and exploded. These Group 1 *alkali metals* can be very dangerous".

4 (a) Group 1 metals are stored under oil.

Suggest why.

.....

(1 mark)

4 (b) Balance the equation which represents the reaction between sodium and water.

$$Na + H_2O \rightarrow NaOH + H_2$$

(1 mark)

4 (c) Explain why the Group 1 metals are called the *alkali metals*.

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(1 mark)

4 (d) Explain, in terms of electrons, why potassium reacts more violently than sodium.

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(3 marks)

6

4.3.1.1 Conservation of mass and balanced chemical equations

Question 10

November 2008 | CHY1AP | Original Q7 | Legacy

QUESTION SEVEN

- Calcium reacts with water in this way:

$$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$$

- Magnesium reacts in a similar way.
- Neither calcium nor magnesium can be obtained from their oxides by carbon reduction.

7A Look at the equation for the reaction between calcium and water.

On each side of the equation, there is a total of . . .

1 2 compounds.

2 4 elements.

3 6 atoms.

4 7 atoms.

7B The information given suggests that calcium is . . .

1 more reactive than both hydrogen and carbon.

2 more reactive than hydrogen but less reactive than carbon.

3 less reactive than hydrogen but more reactive than carbon.

4 less reactive than either hydrogen or carbon.

7C Which of the following is a correctly balanced equation for the reaction between calcium and nitric acid?

1 $2Ca + 2HNO_3 \rightarrow 2Ca(NO_3)_2 + H_2$

2 $Ca + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2$

3 $2Ca + HNO_3 \rightarrow 2Ca(NO_3)_2 + H_2$

4 $Ca + 2HNO_3 \rightarrow 2Ca(NO_3)_2 + 2H_2$

4.3.1.1 Conservation of mass and balanced chemical equations

Question 10 · continued

7D Calcium and magnesium are both in Group 2 of the periodic table.

This suggests that . . .

1 they are two of about 100 non-metallic elements.

2 their carbonates are likely to decompose differently on heating.

3 they are likely to be extracted from their ores by similar methods.

4 their carbonates will form the metal oxide and oxygen on heating.

Turn over for the next question

4.3.1.1 Conservation of mass and balanced chemical equations

Question 11

November 2008 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

Benzene is a chemical which used to be obtained from whale oil. It is now mainly manufactured from crude oil, but it can also be obtained from coal. It is an extremely useful substance in the chemical industry, but it is very toxic. The chemical formula for benzene is C_6H_6

9A Which of the following statements about benzene is true?

1 It is a hydrocarbon.

2 It is an alkane.

3 It is a mixture.

4 It is safe to use as a fuel.

9B The equation below for the combustion of benzene is **not** balanced.

$$2C_6H_6 \quad + \quad \ldots\ldots O_2 \quad \rightarrow \quad 12CO_2 \quad + \quad 6H_2O$$

How many oxygen molecules would be required to balance the equation?

1 12

2 15

3 18

4 30

9C Benzene burns with a very smoky flame, producing lots of soot.

This is because . . .

1 it is manufactured from crude oil.

2 it has very large molecules.

3 it has a high ratio of carbon to hydrogen atoms.

4 it is very toxic.

9D The price of benzene is increasing.

This could be because . . .

1 whales are harder to catch.

2 there is no demand for benzene.

3 it is obtained from a renewable resource.

4 the costs of crude oil and coal are rising.

END OF TEST

4.3.1.1 Conservation of mass and balanced chemical equations

Question 12

March 2009 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

A scientist investigated the chemistry of four metals, **W**, **X**, **Y** and **Z**.

These are the results.

- The oxides of **W** and **Y** were reduced to the metal when mixed with carbon and heated.
- The oxide of **Z** could not be reduced by heating with carbon.
- The oxide of **X** decomposed to the metal on heating alone.
- **Y** gave off hydrogen gas with dilute acid but **W** and **X** did not.

9A Starting with the most reactive, what is the order of reactivity for the four metals?

1 **X**, **W**, **Y**, **Z**

2 **Z**, **Y**, **W**, **X**

3 **X**, **W**, **Z**, **Y**

4 **Z**, **W**, **Y**, **X**

9B Which metal is most likely to be found in the ground as the pure metal?

1 **W**

2 **X**

3 **Y**

4 **Z**

9C How would metal **Z** be produced?

1 by mixing the oxide of **Z** with carbon and heating

2 by mixing an oxide of **Z** with the metal **W** and heating

3 by electrolysis of a molten oxide of **Z**

4 by heating the oxide of **Z** in a stream of hydrogen gas

4.3.1.1 Conservation of mass and balanced chemical equations

Question 12 · continued March 2009 | CHY1AP | Original Q9 | Legacy

9D The equation for the reduction of the oxide of **W** to the metal **W** can be represented by the following equation:

$$2\mathbf{W}_2O_3 + \boldsymbol{q}C = 3CO_2 + \boldsymbol{r}\mathbf{W}$$

What values of ***q*** and ***r*** are needed to balance the equation?

1 ***q*** = 3 and ***r*** = 4

2 ***q*** = 2 and ***r*** = 2

3 ***q*** = 4 and ***r*** = 2

4 ***q*** = 3 and ***r*** = 2

END OF TEST

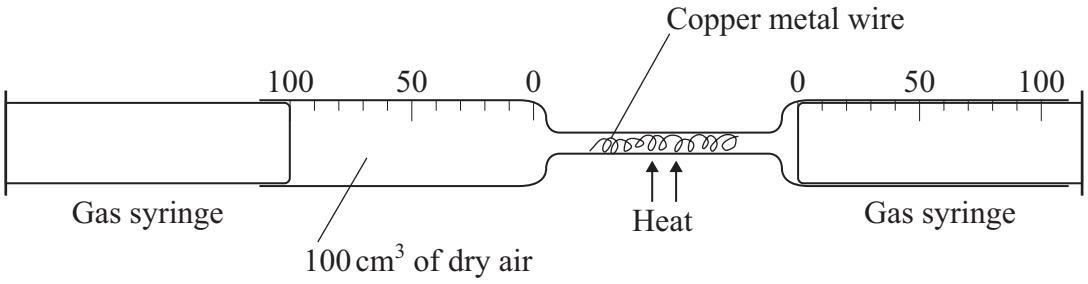
4.3.1.1 Conservation of mass and balanced chemical equations

Question 13

March 2009 | CHY1BP | Original Q5 | Legacy

QUESTION FIVE

The diagram shows some apparatus that is used to investigate the composition of air.



100 cm^3 of dry air was passed backwards and forwards over heated copper metal wire, using the gas syringes.
The copper reacts with oxygen in the dry air to produce copper oxide.
The process was continued until there was no further reduction in the volume of the gases in the syringes. The apparatus was then allowed to cool.

5A Why is it important to continue heating to a constant volume?

1 The volume of air is greater at higher temperatures.

2 Copper oxide will decompose as the apparatus cools.

3 To be sure that all the oxygen in the air has reacted.

4 So that all of the copper has been converted to copper oxide.

5B What was the final volume of gas left in the syringes at the end of the experiment?

1 40 cm^3

2 60 cm^3

3 80 cm^3

4 100 cm^3

4.3.1.1 Conservation of mass and balanced chemical equations

Question 13 · continued

5C Which substance will be the main gas left in the syringes at the end of the experiment?

1 nitrogen

2 oxygen

3 carbon dioxide

4 a noble gas

5D Which of the following is the balanced symbol equation for the reaction between copper and oxygen?

1 $Cu + O_2 \rightarrow CuO$

2 $Cu + 2O_2 \rightarrow CuO$

3 $2Cu + O_2 \rightarrow 2CuO$

4 $2Cu + 2O_2 \rightarrow 2CuO$

4.3.1.1 Conservation of mass and balanced chemical equations

Question 14

June 2009 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

Methane gas (CH_4) burns in oxygen.

This is the chemical equation for the reaction:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A compounds

B bonds

C products

D elements

Methane and oxygen are the reactants but carbon dioxide and water are the . . . **1** . . . of the reaction.

The atoms in carbon dioxide and water are held together by . . . **2** . . . .

Methane, carbon dioxide and water are . . . **3** . . . .

The equation is balanced because in the reaction there is no change in the total number of atoms of each of the . . . **4** . . . .

4.3.1.1 Conservation of mass and balanced chemical equations

Question 15

June 2009 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

Two problems caused by the gases released when fossil fuels are burned are:

- acid rain, caused by sulfur dioxide and oxides of nitrogen
- global warming, caused by carbon dioxide.

Fuel manufacturers have introduced low-sulfur fuels to try to reduce the sulfur dioxide emissions.

6A Low-sulfur fuels were introduced in the UK in 2000. The amount of acid rain gases from transport increased from 2000 to 2004.

This increase could be due to . . .

1 the partial combustion of low-sulfur fuels.

2 an increasing number of vehicles on the UK's roads.

3 increasing emissions of carbon monoxide.

4 some sulfur dioxide not dissolving in rain water.

6B Carbon monoxide and oxides of nitrogen can be removed by a catalytic converter in the exhaust system of vehicles. The two gases, carbon monoxide (CO) and nitrogen dioxide (NO_2), react to produce carbon dioxide (CO_2) and nitrogen (N_2).

The balanced equation that correctly describes this reaction is . . .

1 $CO + NO_2 \rightarrow CO_2 + N_2$

2 $2CO + NO_2 \rightarrow 2CO_2 + N_2$

3 $3CO + 2NO_2 \rightarrow 3CO_2 + N_2$

4 $4CO + 2NO_2 \rightarrow 4CO_2 + N_2$

6C The conversion of carbon monoxide and nitrogen dioxide to carbon dioxide and nitrogen will . . .

1 decrease acid rain and decrease global warming.

2 decrease acid rain and increase global warming.

3 increase acid rain and increase global warming.

4 increase acid rain and decrease global warming.

4.3.1.1 Conservation of mass and balanced chemical equations

Question 15 · continued

6D Environmentalists have encouraged the use of hydrogen as a fuel instead of petrol because . . .

1 hydrogen is a renewable fuel obtained from sugar.

2 carbon monoxide is the main product of combustion.

3 no carbon dioxide is produced when hydrogen is burned.

4 hydrogen produces only low levels of sulfur dioxide when burned.

Turn over for the next question

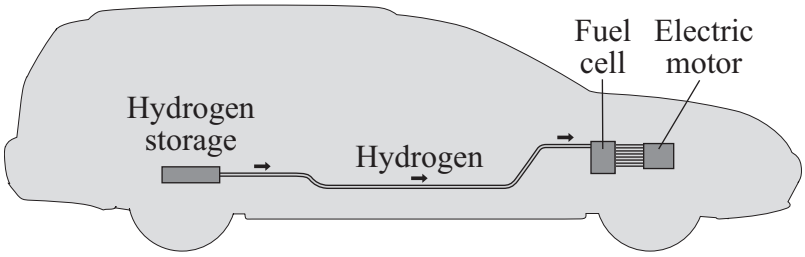
4.3.1.1 Conservation of mass and balanced chemical equations

Question 16

June 2009 | CHY2H | Original Q5 | Legacy

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

Hydrogen fuel for cars?



Hydrogen is an excellent fuel. It can be made by the electrolysis of potassium hydroxide solution.

Hydrogen gas can be stored under pressure in a cylinder but a leak of the gas could cause an explosion.

It has been found that lithium nitride can absorb and then release large volumes of hydrogen. A chemical reaction takes place between the hydrogen and the lithium nitride. The hydrogen is held in the resulting compounds by chemical bonds.

The problem is that the rate at which hydrogen is absorbed and then released from normal sized particles of lithium nitride is slow.

Recently scientists have made 'nanosized' particles of lithium nitride. These particles absorb hydrogen in the same way as normal sized lithium nitride particles. The 'nanosized' particles have the advantage that they absorb and release the hydrogen much faster when needed in the fuel cell.

It is hoped that 'nanosized' particles of lithium nitride may provide a safe method of storing hydrogen in the future.

4.3.1.1 Conservation of mass and balanced chemical equations

Question 16 · continued

for mark

5 (a) Hydrogen is produced at the negative electrode during the electrolysis of potassium hydroxide solution.

5 (a) (i) Why are hydrogen ions attracted to the negative electrode?

.....

.....

.....

(1 mark)

5 (a) (ii) Potassium ions are also attracted to the negative electrode.

Explain why hydrogen gas is formed but not potassium.

.....

.....

.....

(1 mark)

5 (b) Lithium nitride is made by reacting lithium with nitrogen.

Balance the equation for this reaction.

..... Li + N_2 → ..... Li_3N

(1 mark)

Question 5 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

Question 16 · continued

for mark

5 (c) (i) The equation for the reaction of lithium nitride with hydrogen is:

$$Li_3N + 2H_2 \rightleftharpoons LiNH_2 + 2LiH$$

What feature of this reaction allows the hydrogen to be released?

.....

.....

(1 mark)

5 (c) (ii) Hydrogen stored in a fuel tank filled with lithium nitride would be safer in an accident than a cylinder full of hydrogen.

Suggest and explain why.

.....

.....

.....

.....

.....

(2 marks)

5 (d) (i) State how 'nanosized' particles will be different from normal sized particles of lithium nitride.

.....

.....

(1 mark)

5 (d) (ii) Suggest why the 'nanosized' particles of lithium nitride absorb and release the hydrogen more quickly than normal sized particles.

.....

.....

.....

(1 mark)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 16 · continued

for mark

5 (e) Lithium nitride is an ionic compound which contains lithium ions (Li^{+}) and nitride ions (N^{3-}).

5 (e) (i) The formation of a lithium ion from a lithium atom is an oxidation reaction.

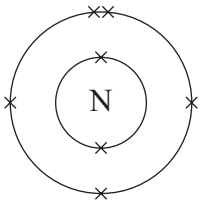
Explain why.

.....

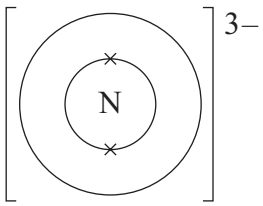
.....

(1 mark)

5 (e) (ii) The diagram shows the electronic structure of a nitrogen atom.



Complete the diagram below to show the electronic structure of a nitride ion (N^{3-}).



(1 mark)

10

4.3.1.1 Conservation of mass and balanced chemical equations

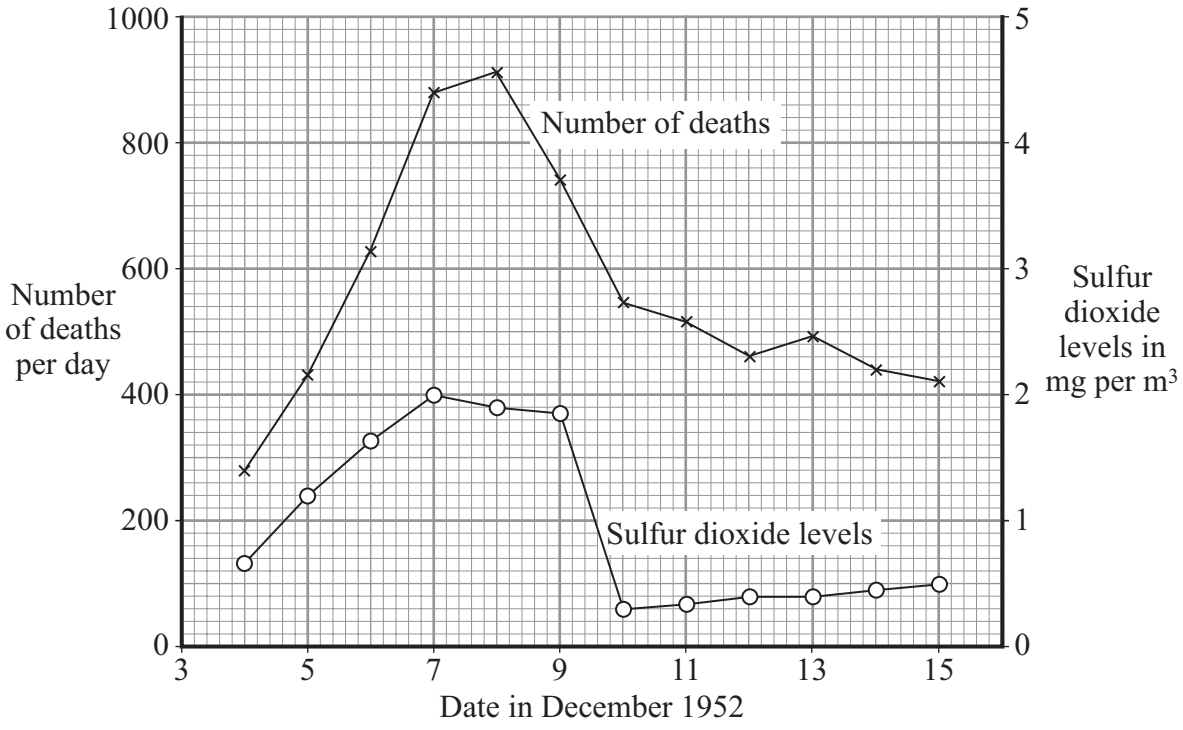
Question 17

November 2009 | CHY1AP | Original Q7 | Legacy

QUESTION SEVEN

Smog is a mixture containing sulfur dioxide and smoke particles.

The graph below shows how the number of deaths due to sulfur dioxide varied during the Great Smog in London during December 1952.



7A It is generally agreed that sulfur dioxide caused the increase in the number of deaths in London in December 1952.

Which of the following would be the best argument **against** this conclusion?

1 The level of sulfur dioxide does **not** go as high as the number of deaths.

2 After a period of time, the sulfur dioxide levels increase but the number of deaths decreases.

3 The graphs show a similar pattern of increase and decrease.

4 The number of deaths increases faster than the sulfur dioxide levels increase.

4.3.1.1 Conservation of mass and balanced chemical equations

Question 17 · continued

7B A group of students studying the Great Smog of London in 1952 wrote four statements after looking at the data.

Which one of their statements is correct?

1 The number of deaths peaks on the same day as sulfur dioxide levels peak.

2 The number of deaths always increases when sulfur dioxide levels increase.

3 On the day that sulfur dioxide levels reached 2 mg per m^3, there were 880 deaths.

4 If sulfur dioxide levels double, the number of deaths doubles.

7C Many cars now use low-sulfur fuels that were introduced in 2000. However, the amount of sulfur dioxide emissions from vehicles in the UK has increased since 2000.

This increase is because . . .

1 early versions of low-sulfur fuels did not burn correctly.

2 there is an increasing number of vehicles on UK roads.

3 there is now 5 % ethanol (C_2H_5OH) in petrol.

4 sulfur dioxide is producing acid rain.

7D Sulfur dioxide can be removed from the waste gases from power stations using a process called flue gas desulfurisation. This is done by reacting the sulfur dioxide [SO_2] with calcium carbonate [$CaCO_3$], calcium oxide [CaO], calcium hydroxide [$Ca(OH)_2$] or magnesium oxide [MgO].

Which one of the following is **not** a correctly balanced equation for a reaction taking place during *flue gas desulfurisation*?

1 $SO_2 + MgO \rightarrow MgSO_3$

2 $SO_2 + CaO \rightarrow CaSO_3$

3 $SO_2 + CaCO_3 \rightarrow CaSO_3 + CO_2$

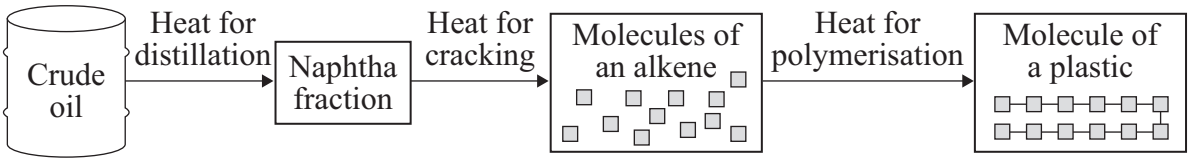
4 $SO_2 + Ca(OH)_2 \rightarrow CaSO_3 + 2H_2O$

4.3.1.1 Conservation of mass and balanced chemical equations

Question 18

January 2010 | CHY1H | Original Q6 | Legacy

6 To make a plastic, such as poly(ethene), from crude oil involves many processes.



6 (a) Describe how crude oil is separated into fractions.

.....

.....

.....

.....

.....

(2 marks)

6 (b) Ethene is produced by cracking the hydrocarbons in the naphtha fraction.

6 (b) (i) Balance the symbol equation for this reaction.

$C_{10}H_{22}$	→	C_4H_{10}	+	C_2H_4
decane		butane		ethene

(1 mark)

6 (b) (ii) Describe how cracking is carried out.

.....

.....

.....

.....

.....

(2 marks)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 18 · continued

for mark

6 (c) Alkanes, such as butane (C_4H_{10}), do **not** form polymers.

Alkenes, such as ethene (C_2H_4), do form polymers.

Explain these statements.

.....

.....

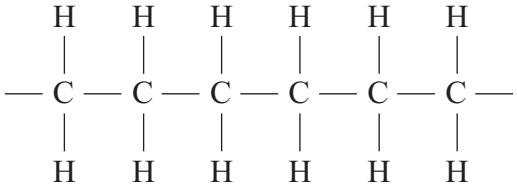
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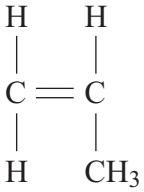
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(2 marks)

6 (d) Ethene molecules form the polymer poly(ethene). One molecule in poly(ethene) will contain thousands of carbon atoms. The diagram represents part of a poly(ethene) molecule.



Propene molecules form the polymer poly(propene).



Propene molecule

Draw a diagram to represent part of a poly(propene) molecule.

(2 marks)

9

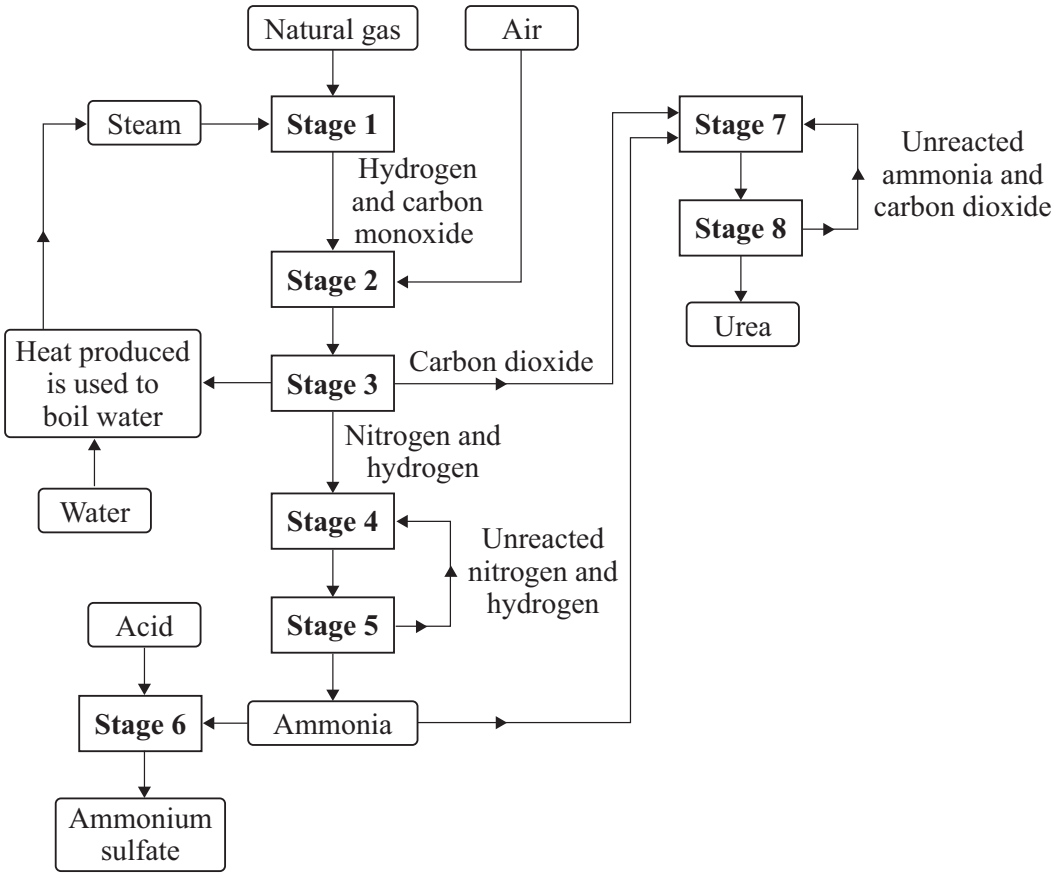
4.3.1.1 Conservation of mass and balanced chemical equations

Question 19

January 2010 | CHY2H | Original Q6 | Legacy

6 Ammonium sulfate and urea are made from ammonia.
These compounds are used by farmers.

The flow diagram shows the stages to make ammonium sulfate and urea.



6 (a) Give **two** examples from the flow diagram of efficient use of energy or materials.

.....

.....

.....

.....

(2 marks)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 19 · continued January 2010 | CHY2H | Original Q6 | Legacy

for mark

6 (b) Why do farmers use ammonium compounds?

.....

.....

(1 mark)

6 (c) The equation for a reaction that takes place in **Stage 1** is given below.

Balance this equation by putting the correct number on the dotted line.

$$CH_4 + H_2O \rightarrow CO + \ldots\ldots H_2$$

(1 mark)

6 (d) The equation for the reaction in **Stage 4** is shown below.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

6 (d) (i) Explain why, at equilibrium, the yield of ammonia for this reaction is greater at **low** temperatures.

.....

.....

(1 mark)

6 (d) (ii) Explain why a high temperature, 450 °C, is used in **Stage 4**.

.....

.....

(1 mark)

6 (e) Name the acid used in **Stage 6** to make ammonium sulfate.

..... acid

(1 mark)

Question 6 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

Question 19 · continued

for mark

6 (f) **Stage 7** can be represented by this equation.

$$\underset{\text{ammonia}}{2NH_3} + CO_2 \rightarrow \underset{\text{urea}}{NH_2CONH_2} + H_2O$$

The table gives the relative formula masses (M_r) of the reactants and the products for this reaction.

Formula of reactant or product	Relative formula masses (M_r)
NH_3	17
CO_2	44
NH_2CONH_2	60
H_2O	18

Use information from the table to help you answer (f)(i) and (f)(ii).

6 (f) (i) One factory produces 6000 g of urea each second. Calculate the mass of ammonia needed to make 6000 g of urea.

.....

.....

.....

.....

Mass of ammonia needed = ... g

(3 marks)

6 (f) (ii) Percentage atom economy can be calculated using:

$$\text{Percentage atom economy} = \frac{M_r \text{ of useful product}}{\text{total } M_r \text{ of all reactants added together}} \times 100\%$$

Calculate the percentage atom economy for the reaction in **Stage 7**

.....

.....

.....

Percentage atom economy = ... %

(2 marks)

12

4.3.1.1 Conservation of mass and balanced chemical equations

Question 20

March 2010 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

Titanium cannot be extracted by carbon reduction of its ore, which contains titanium dioxide, TiO_2

Titanium is obtained from titanium dioxide in two stages.

In **Stage 1**, the titanium dioxide is converted to titanium chloride ($TiCl_4$).

titanium dioxide + chlorine + carbon → titanium chloride + carbon dioxide

The possible escape of carbon dioxide and chlorine (a poisonous gas) can cause damage to the environment.

In **Stage 2**, the titanium chloride formed is reacted with sodium.

titanium chloride + sodium → titanium + sodium chloride

The sodium chloride formed is removed by washing the titanium with hydrochloric acid but the disposal of the acidic sodium chloride solution causes another environmental problem.

6A Which of the following is a correctly balanced equation for **Stage 2**?

1 $TiCl_4 + Na \rightarrow 4Ti + NaCl$

2 $TiCl_4 + Na \rightarrow Ti + 4NaCl$

3 $TiCl_4 + 4Na \rightarrow 4Ti + 4NaCl$

4 $TiC1_4 + 4Na \rightarrow Ti + 4NaCl$

6B Sodium, not carbon, is used to extract titanium from its compounds.

Which row in the table does this information suggest to be the order of reactivity for carbon, sodium and titanium?

	Most reactive →		**Least reactive**
1	Sodium	Titanium	Carbon
2	Sodium	Carbon	Titanium
3	Titanium	Sodium	Carbon
4	Carbon	Titanium	Sodium

4.3.1.1 Conservation of mass and balanced chemical equations

Question 20 · continued March 2010 | CHY1AP | Original Q6 | Legacy

6C In **Stage 1**, the gases carbon dioxide and chlorine should **not** be allowed to escape into the air because . . .

1 both add to global dimming.

2 both are poisonous gases.

3 carbon dioxide adds to global warming and chlorine is toxic.

4 carbon dioxide adds to global dimming and chlorine is expensive.

6D In **Stage 2**, the best way to dispose of the acidic sodium chloride solution is . . .

1 to pump it into the ocean.

2 to pump it into landfill sites.

3 to boil the solution until all the acid has evaporated.

4 to separate the acid from the salt so that both can be used in other chemical processes.

4.3.1.1 Conservation of mass and balanced chemical equations

Question 21

March 2010 | CHY1BP | Original Q5 | Legacy

QUESTION FIVE

Some properties of two forms of poly(ethene) are shown in the table.

Polymer	Density in kg per m^3	Tensile strength in MPa
Low-density poly(ethene) – LDPE	925	16
High-density poly(ethene) – HDPE	950	28

The molecules of low-density poly(ethene) and high-density poly(ethene) are represented in the diagrams.

Low-density poly(ethene) – LDPE



High-density poly(ethene) – HDPE



5A The reason for the differences in strength and density between LDPE and HDPE is that . . .

1 they contain different elements in their structure.

2 they were made under different conditions.

3 they have different colours added.

4 different monomers are used to make the chains.

5B HDPE has a higher density than LDPE because . . .

1 it is stronger.

2 more plastic is used to make LDPE.

3 the polymer molecules pack closer together in HDPE.

4 LDPE has shorter polymer chains.

4.3.1.1 Conservation of mass and balanced chemical equations

Question 21 · continued March 2010 | CHY1BP | Original Q5 | Legacy

5C Which is the most appropriate method for disposal of a non-biodegradable polymer such as poly(ethene)?

1 freeze it so that it returns to the original monomer

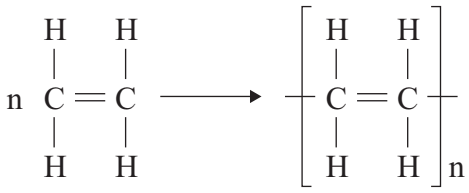
2 dispose of it at sea

3 bury it in the ground

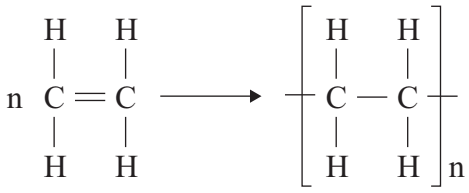
4 break it down by adding microorganisms

5D Which one of the following is the correct balanced equation for the polymerisation of ethene to form poly(ethene)?

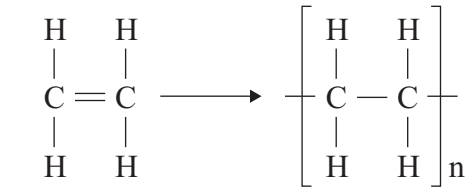
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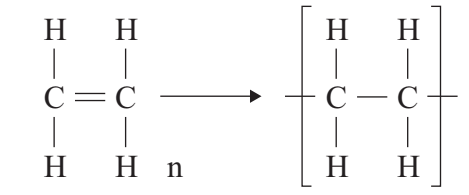
2



3



4



4.3.1.1 Conservation of mass and balanced chemical equations

Question 22

June 2010 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

This question is about metals.

9A A scientist investigated some reactions of three metals, **K**, **L** and **M**.

- Metal **L** can be extracted by mixing its oxide with carbon and heating.
- Metal **M** cannot be extracted by mixing its oxide with carbon and heating.
- Hydrogen will displace metal **K** from its oxide but will not displace metal **L** from its oxide.
- The oxide of metal **K** is decomposed to the metal on heating alone.

The order of reactivity for the three metals, with the most reactive first, is . . .

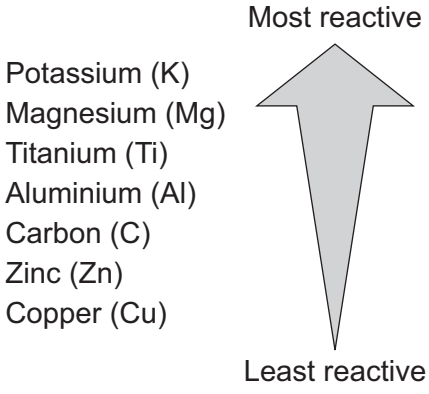
1 **K, L, M.**

2 **M, L, K.**

3 **L, K, M.**

4 **K, M, L.**

9B The order of reactivity for several metals and carbon is shown below.



Which of the following shows a correctly balanced equation for a possible reaction?

1 $ZnO + C \rightarrow Zn + CO_2$

2 $Cu + MgO \rightarrow CuO + Mg$

3 $2Mg + K_2O \rightarrow 2MgO + 2K$

4 $2Al + 3ZnO \rightarrow 3Zn + Al_2O_3$

4.3.1.1 Conservation of mass and balanced chemical equations

Question 22 · continued

Titanium is extracted from titanium chloride by mixing the titanium chloride with sodium and heating the mixture. The reaction is carried out in a furnace above 500 °C.

It is a batch process; this means that the furnace does not operate continuously but is cooled after each operation so that the titanium can be removed.

9C Which row in the table correctly describes the reaction for the extraction of titanium?

	Why the reaction occurs	Products of the reaction
1	Sodium is more reactive than titanium	Titanium, sodium and chlorine
2	Titanium is more reactive than sodium	Titanium and chlorine
3	Titanium is more reactive than sodium	Titanium and sodium chloride
4	Sodium is more reactive than titanium	Titanium and sodium chloride

9D The extraction of iron in a blast furnace is a continuous process.

Over a period of 12 months, the batch method for extraction of titanium requires much more energy per tonne of metal than the continuous method for the extraction of iron.

This is because . . .

1 the batch process is completed more quickly.

2 iron is less reactive than titanium.

3 the furnace is not maintained at a high temperature.

4 titanium chloride is not as pure as iron oxide.

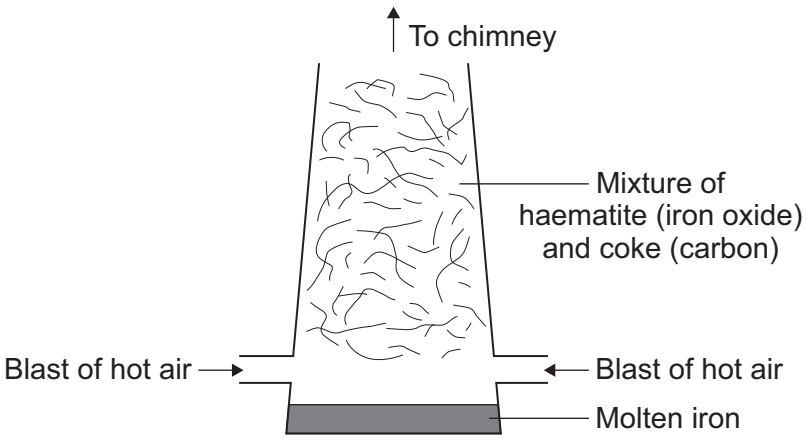
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4.3.1.1 Conservation of mass and balanced chemical equations

Question 23

June 2010 | CHY1H | Original Q3 | Legacy

3 Iron is produced by reacting a mixture of haematite and coke in a blast furnace.
Haematite is an ore of iron containing iron oxide (Fe_2O_3).
Coke is made from coal and is almost pure carbon.



3 (a) (i) The coke burns in air. This reaction heats the furnace to above 1300 °C.

Complete the chemical equation for carbon reacting with oxygen to form carbon dioxide.

..... + O_2 → CO_2

(1 mark)

3 (a) (ii) Carbon monoxide is also formed in the furnace. Carbon monoxide reacts with iron oxide to produce iron and carbon dioxide.

iron oxide + carbon monoxide → iron + carbon dioxide

Complete and balance the chemical equation for the production of iron.

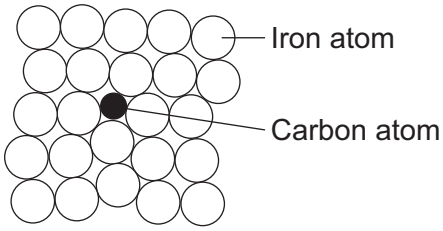
Fe_2O_3 + 3CO → ..... + ...

(2 marks)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 23 · continued

3 (a) (iii) Iron from a blast furnace is called cast iron and contains about 4% carbon.



Why is pure iron softer than cast iron?

.....

.....

.....

(1 mark)

3 (b) Steel is made by reducing the percentage of carbon in cast iron and then adding different metals to form the type of steel required.

In the UK we use about 1.8 billion steel cans every year but only 30% of these are recycled. Recycling reduces waste. Producing steel from recycled cans requires only 25% of the energy needed to make steel from iron ore.

Give **three** environmental benefits of recycling a higher percentage of used steel cans.

1 .....

.....

2 .....

.....

3 .....

.....

(3 marks)

7

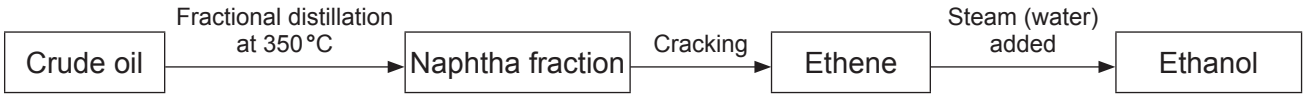
4.3.1.1 Conservation of mass and balanced chemical equations

Question 24

June 2010 | CHY1H | Original Q6 | Legacy

6 Petrol sold in most countries now contains at least 5% ethanol.
The production of ethanol, for use as a fuel, is being increased.

The flow diagram shows how ethanol can be produced from crude oil.



6 (a) Why does crude oil need to be fractionally distilled?

.....

.....

(1 mark)

6 (b) Hydrocarbons, such as decane, in the naphtha fraction are cracked to produce ethene.
The balanced chemical equation shows the cracking of decane.

$$\underset{\text{decane}}{C_{10}H_{22}} \rightarrow \underset{\text{octane}}{C_8H_{18}} + \underset{\text{ethene}}{C_2H_4}$$

6 (b) (i) Describe how cracking is done.

.....

.....

.....

.....

(2 marks)

6 (b) (ii) Complete the structural formula of ethene by drawing lines to represent each covalent bond.

H H

C C

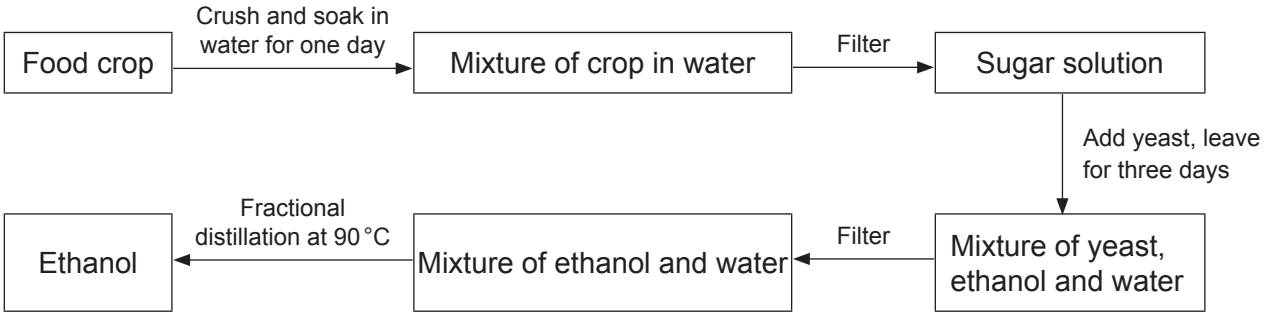
H H

(1 mark)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 24 · continued

6 (c) The flow diagram below shows how ethanol, for use as a fuel, can also be produced from food crops.



Use the information in the two flow diagrams and your own knowledge and understanding to evaluate whether more of this ethanol should be produced from food crops or from crude oil.

Remember to give a conclusion to your evaluation.

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(5 marks)

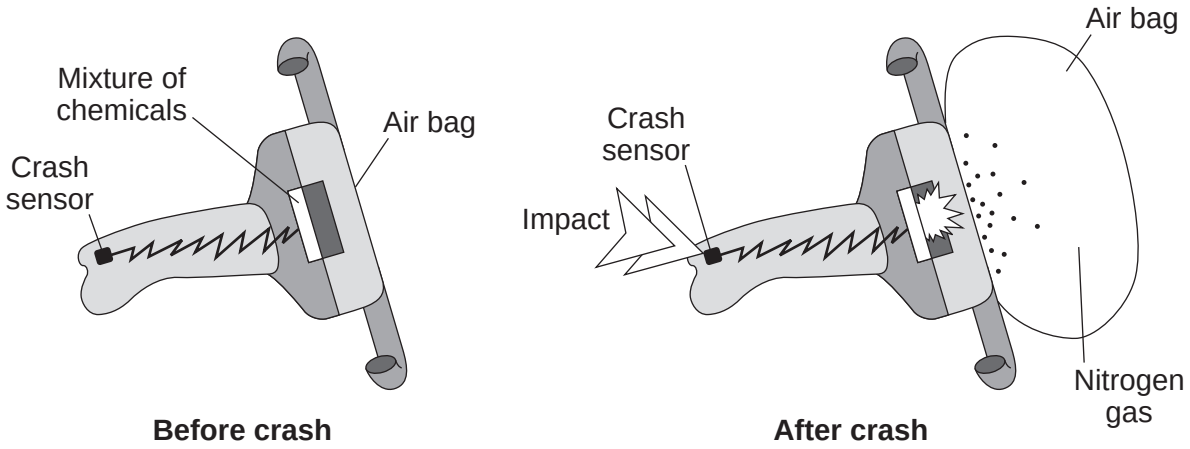
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4.3.1.1 Conservation of mass and balanced chemical equations

Question 25

June 2010 | CHY2H | Original Q4 | Legacy

4 Air bags are used to protect the passengers in a car during an accident. When the crash sensor detects an impact it causes a mixture of chemicals to be heated to a high temperature. Reactions take place which produce nitrogen gas. The nitrogen fills the air bag.



4 (a) The mixture of chemicals contains sodium azide (NaN_3) which decomposes on heating to form sodium and nitrogen.

$$2NaN_3 \rightarrow 2Na + 3N_2$$

A typical air bag contains 130 g of sodium azide.

4 (a) (i) Calculate the mass of nitrogen that would be produced when 130 g of sodium azide decomposes.

Relative atomic masses (A_r): N = 14; Na = 23

.....

.....

.....

.....

Mass of nitrogen = ... g

(3 marks)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 25 · continued June 2010 | CHY2H | Original Q4 | Legacy

4 (a) (ii) 1 g of nitrogen has a volume of 0.86 litres at room temperature and pressure.

What volume of nitrogen would be produced from 130 g of sodium azide?

(If you did not answer part (a)(i), assume that the mass of nitrogen produced from 130 g of sodium azide is 80 g. This is **not** the correct answer to part (a)(i).)

.....

Volume = ... litres
(1 mark)

4 (b) The sodium produced when the sodium azide decomposes is dangerous.
The mixture of chemicals contains potassium nitrate and silicon dioxide which help to make the sodium safe.

4 (b) (i) Sodium reacts with potassium nitrate to make sodium oxide, potassium oxide and nitrogen. Complete the balancing of the equation for this reaction.

$$10Na + ...KNO_3 \rightarrow .....Na_2O + K_2O + N_2$$

(1 mark)

4 (b) (ii) The silicon dioxide reacts with the sodium oxide and potassium oxide to form silicates.

Suggest why sodium oxide and potassium oxide are dangerous in contact with the skin.

.....

.....
(1 mark)

6

4.3.1.1 Conservation of mass and balanced chemical equations

Question 26

November 2010 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

The table shows the quantity of acidic gases produced in Britain, from different sources, between 1990 and 2004.

	Acidic gases produced in millions of tonnes			
Year	**Domestic**	**Transport and communications**	**Other industries**	**Total**
1990	0.75	0.75	5.40	6.90
1992	0.75	0.80	5.00	6.55
1994	0.70	0.80	4.10	5.60
1996	0.60	0.80	3.40	4.80
1998	0.50	0.85	2.90	4.25
2000	0.45	0.70	2.50	3.65
2002	0.40	0.85	2.15	3.40
2004	0.35	0.90	2.05	3.30

6A The decrease in the total amount of acidic gases produced between 1990 and 2004 is about . . .

1 5%.

2 25%.

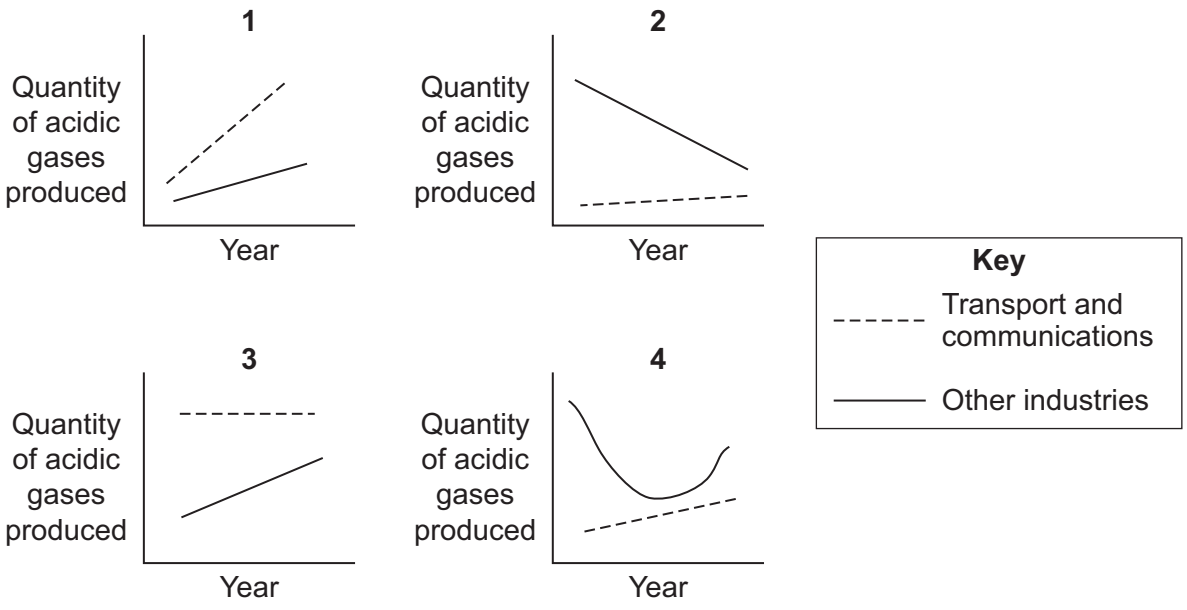
3 50%.

4 75%.

4.3.1.1 Conservation of mass and balanced chemical equations

Question 26 · continued

6B Which graph correctly shows the data in the table for 'Transport and communications' and for 'Other industries'?



6C In 2000, 'Transport and communications' produced an unexpected amount of acidic gases, when compared to the trend in values.

Which one of the following could help to explain the unexpected amount of acidic gases produced?

1 a decrease in the number of aircraft flights

2 a decrease in the cost of crude oil

3 more traffic on the roads because of an increase in car production

4 more homes being built in the countryside

6D A catalytic converter in the exhaust system of vehicles can remove carbon monoxide and nitrogen dioxide. The two gases, carbon monoxide (CO) and nitrogen dioxide (NO_2), react to produce carbon dioxide (CO_2) and nitrogen (N_2).

The balanced equation that correctly describes this reaction is:

1 $CO + NO_2 \rightarrow CO_2 + N_2$

2 $2CO + NO_2 \rightarrow 2CO_2 + N_2$

3 $3CO + 2NO_2 \rightarrow 3CO_2 + N_2$

4 $4CO + 2NO_2 \rightarrow 4CO_2 + N_2$

4.3.1.1 Conservation of mass and balanced chemical equations

Question 27

January 2011 | CHY1H | Original Q4 | Legacy

4 Titanium is used for replacement hip joints because it has a low density, is strong and does not corrode.
Titanium is extracted from titanium dioxide (TiO_2) in three stages.

4 (a) **Stage 1**
Titanium dioxide is converted into titanium chloride ($TiCl_4$) because the metal cannot be extracted from its oxide by *reduction* with carbon.

4 (a) (i) What does *reduction* mean?

.....

.....

(1 mark)

4 (a) (ii) Balance the chemical equation for the conversion of titanium dioxide to titanium chloride.

TiO_2 + Cl_2 + C → $TiCl_4$ + CO_2

(1 mark)

4 (a) (iii) Chemical equations are always balanced. Explain why.

.....

.....

.....

(1 mark)

4 (b) **Stage 2**
Titanium is extracted from the titanium chloride by reacting it with sodium at 1000 °C in a reactor.
The only other substance in the reactor is argon gas.

$TiCl_4$ + 4Na → Ti + 4NaCl

4 (b) (i) What does this tell you about the reactivity of sodium compared with titanium?

.....

.....

(1 mark)

4 (b) (ii) Suggest why the reactor contains argon and **not** air.

.....

.....

(1 mark)

4.3.1.1 Conservation of mass and balanced chemical equations

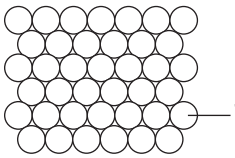
Question 27 · continued

4 (c) **Stage 3**

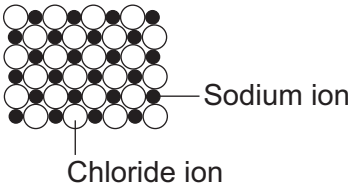
After **Stage 2** the titanium is separated from the products by washing out the sodium chloride with water.

The diagrams show sections through the lattice of titanium metal and the lattice of sodium chloride.

Titanium



Sodium chloride



How do the diagrams show that:

4 (c) (i) titanium is an element

.....

.....

(1 mark)

4 (c) (ii) sodium chloride is a compound?

.....

.....

.....

.....

(2 marks)

8

4.3.1.1 Conservation of mass and balanced chemical equations

Question 28

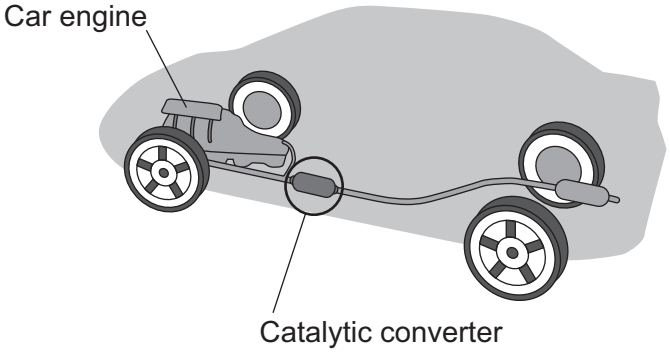
January 2011 | CHY2H | Original Q4 | Legacy

4 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.



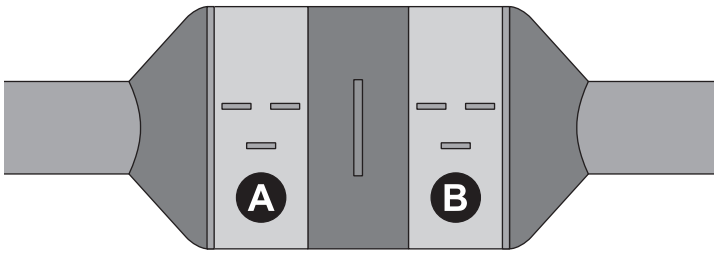
4 (a) The reaction is *exothermic*. What is the meaning of *exothermic*?

.....

.....

(1 mark)

4 (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.

4.3.1.1 Conservation of mass and balanced chemical equations

Question 28 · continued

4 (b) (i) Why are catalysts used in chemical reactions?

.....

.....

(1 mark)

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

$$2NO \rightarrow N_2 + O_2$$

Suggest why this reaction helps the environment.

.....

.....

(1 mark)

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

Balance this equation.

..... CO + O_2 → ..... CO_2

(1 mark)

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

Explain why the catalyst does not need to be replaced.

.....

.....

(1 mark)

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

.....

.....

(1 mark)

Question 4 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

Question 28 · continued

4 (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.

.....

.....

.....

.....

.....

.....

.....

(3 marks)

9

4.3.1.1 Conservation of mass and balanced chemical equations

Question 29

June 2011 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

A mixture of iron oxide and aluminium reacts when heated.

This is the balanced equation for the reaction:

$$Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe$$

Symbols	
Fe	Iron
O	Oxygen
Al	Aluminium

Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A electrons

B bonds

C products

D elements

Iron oxide and aluminium are the reactants. Aluminium oxide and iron are the . . . **1** . . . .

Aluminium atoms and oxygen atoms combine by transferring . . . **2** . . . .

The particles (ions) in aluminium oxide are held together by . . . **3** . . . .

The equation is balanced because, in the reaction, there is no change in the total number of atoms of each of the . . . **4** . . . .

4.3.1.1 Conservation of mass and balanced chemical equations

Question 30

June 2011 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

In 1774, a Frenchman called Antoine Lavoisier put forward this theory:

> "*Matter can neither be created nor destroyed, and in every chemical reaction there is just as much matter present before, as after the reaction has taken place.*"

6A This theory is now an accepted law of chemistry.

This law means that in any chemical reaction . . .

1 the mass of the products is equal to the mass of the reactants.

2 new atoms are produced from the atoms which make up the reactants.

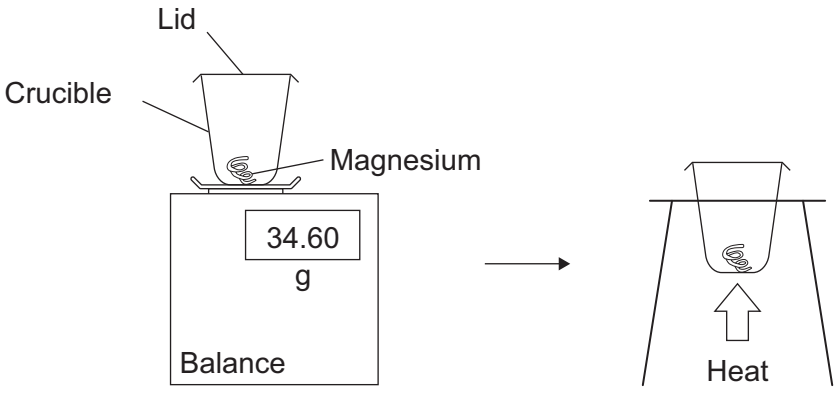
3 the number of molecules of reactants is equal to the number of molecules of products.

4 atoms of elements react by giving, taking or sharing electrons.

A student investigated the reaction when some magnesium burned completely in oxygen.

magnesium + oxygen → magnesium oxide

The student weighed a crucible, its lid and a piece of magnesium.



The student then:

- heated the crucible for one minute, raising the lid occasionally
- allowed the crucible, lid and contents to cool, and then reweighed them
- repeated the heating, cooling and reweighing several times.

4.3.1.1 Conservation of mass and balanced chemical equations

Question 30 · continued

The results are shown in the table.

Total time of heating in minutes	0	1	2	3	4	5	6
Mass of crucible, lid and contents in grams	34.60	34.92	35.00	35.07	35.10	35.10	35.10

6B Which row in the table below correctly explains the procedures in the experiment?

	Reason for:	
	raising the crucible lid occasionally	repeating the heating, cooling and reweighing
1	so the crucible would not get too hot	to check the accuracy of the balance
2	to allow air to enter the crucible	to make sure that all the magnesium had reacted
3	to allow air to enter the crucible	to check the accuracy of the balance
4	so the crucible would not get too hot	to make sure that all the magnesium had reacted

6C Why do the results in this experiment appear to contradict Lavoisier's theory?

1 The mass of reacting oxygen was not included in the weighings.

2 Magnesium oxide is a compound but magnesium and oxygen are elements.

3 There was not enough oxygen for all of the magnesium to react.

4 The mass of magnesium used was too small.

6D From calculations done before the experiment, the student expected the final mass of the crucible, lid and contents to be 35.32 grams rather than 35.10 grams.

The best explanation for this difference is that . . .

1 the student did not heat the crucible to a high enough temperature.

2 some magnesium oxide escaped from the crucible.

3 magnesium oxide begins to decompose at the temperature of the Bunsen burner.

4 the student did not allow the crucible to completely cool each time.

4.3.1.1 Conservation of mass and balanced chemical equations

Question 31

June 2011 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

This question is about the cracking of hydrocarbons.

8A Which of the following is a correctly balanced equation for the cracking of $C_{15}H_{32}$ in which two different alkenes are produced?

1 $C_{15}H_{32} \rightarrow 2C_2H_4 + C_3H_6 + C_8H_{18}$

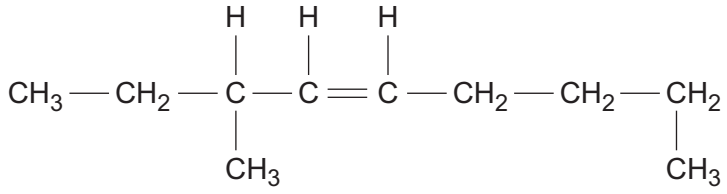
2 $C_{15}H_{32} \rightarrow 2CH_4 + C_3H_6 + C_4H_{10} + C_6H_{12}$

3 $C_{15}H_{32} \rightarrow 2C_3H_6 + C_9H_{20}$

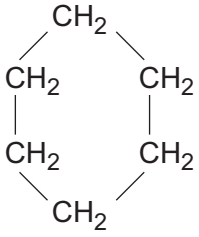
4 $C_{15}H_{32} \rightarrow C_4H_{10} + C_5H_{10} + C_6H_{14}$

8B Which of the following hydrocarbons that could be produced by the cracking of C_9H_{20} has the general formula C_nH_{2n} and decolourises bromine water?

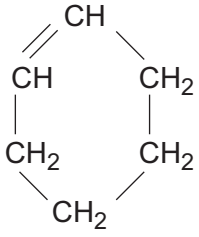
1



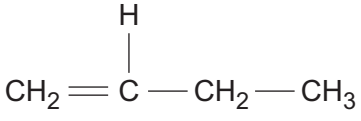
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3



4

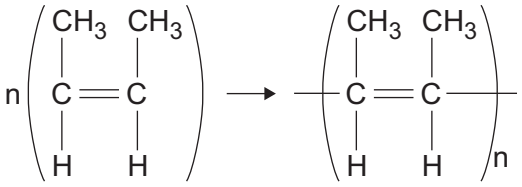


4.3.1.1 Conservation of mass and balanced chemical equations

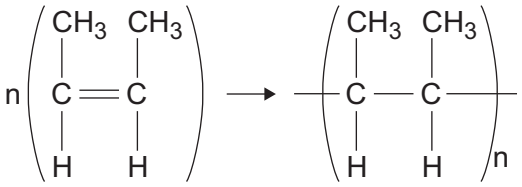
Question 31 · continued

8C Which of the following equations represents the polymerisation of butene?

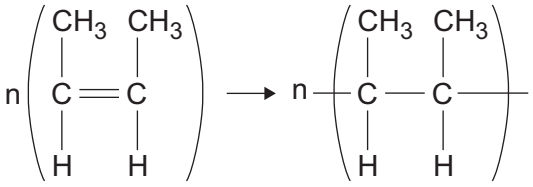
1



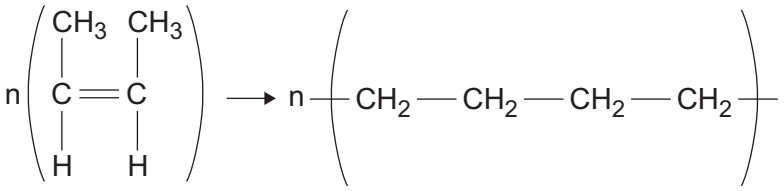
2



3



4



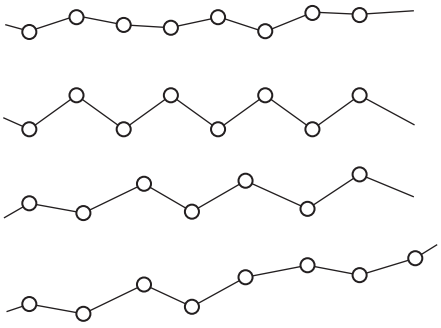
Question 8 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

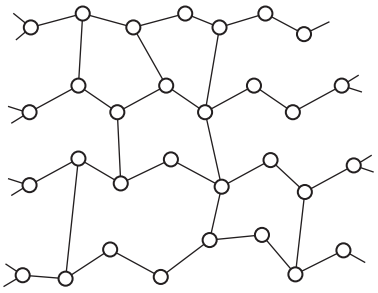
Question 31 · continued

8D The diagram shows the structures of a thermosoftening polymer and a thermosetting polymer.

Thermosoftening polymer



Thermosetting polymer



Which row in the table describes the properties of the two types of polymer?

	Thermosoftening polymer		Thermosetting polymer	
	Property 1	**Property 2**	**Property 1**	**Property 2**
1	Polymer molecules able to slide	Chemical bonds between the chains	Melt on heating	Short chain lengths
2	Long chain lengths	No chemical bonds between the chains	Chemical bonds between the chains	Polymer molecules able to slide
3	Long chain lengths	No chemical bonds between the chains	Do not melt on heating	Chemical bonds between the chains
4	Chemical bonds between the chains	Melt on heating	No chemical bonds between the chains	Long chain lengths

4.3.1.1 Conservation of mass and balanced chemical equations

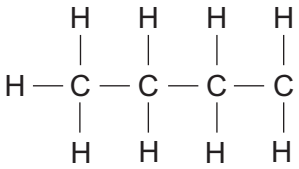
Question 32

June 2011 | CHY1H | Original Q5 | Legacy

5 Crude oil is a mixture of hydrocarbons. Most of these hydrocarbons are alkanes.

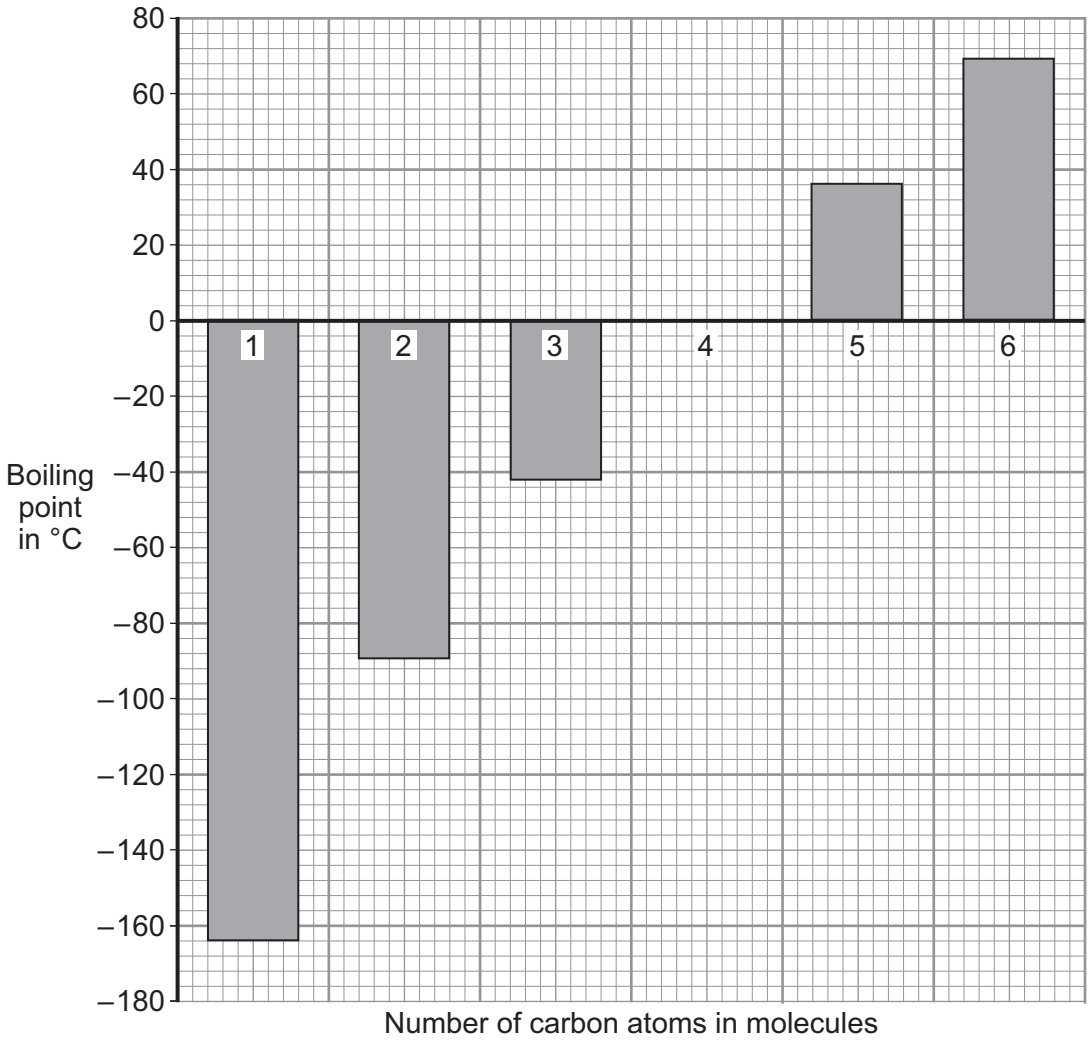
5 (a) The general formula of an alkane is C_nH_{2n+2}

Complete the structural formula for the alkane that has **six** carbon atoms in its molecules.



(1 mark)

5 (b) The boiling points of alkanes are linked to the number of carbon atoms in their molecules.



5 (b) (i) Describe the link between the number of carbon atoms in an alkane molecule and its boiling point.

.....

.....

(1 mark)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 32 · continued

5 (b) (ii) Suggest **two** reasons why all of the alkanes in the bar chart are better fuels than the alkane with the formula $C_{30}H_{62}$

1 .....

.....

2 .....

.....

(2 marks)

5 (c) During the last 200 million years the carbon cycle has maintained the percentage of carbon dioxide in the atmosphere at about 0.03 %.
Over the last 100 years the percentage of carbon dioxide in the atmosphere has increased to about 0.04 %.
Most of this increase is caused by burning fossil fuels to heat buildings, to generate electricity and to power our transport.
Fossil fuels contain carbon that has been locked up for millions of years.

5 (c) (i) Burning fossil fuels, such as petrol, releases this locked up carbon. Balance the chemical equation for the combustion of one of the alkanes in petrol.

$$2\,C_8H_{18} + 25\,O_2 \longrightarrow \text{.....}\ CO_2 + \text{.....}\ H_2O$$

(1 mark)

5 (c) (ii) Where did the carbon that is locked up in fossil fuels come from?

.....

.....

(1 mark)

5 (c) (iii) The burning of fossil fuels has caused the percentage of carbon dioxide in the atmosphere to increase to above 0.03 %.
Explain why.

.....

.....

.....

.....

.....

.....

(2 marks)

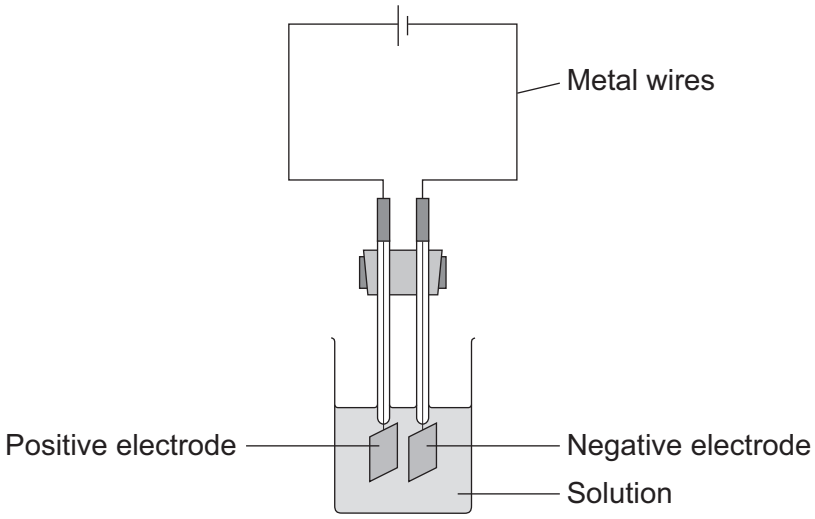
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4.3.1.1 Conservation of mass and balanced chemical equations

Question 33

June 2011 | CHY2H | Original Q5 | Legacy

5 The diagram shows apparatus used by a student to investigate electrolysis.



The student was given a solution by the teacher. The solution contained a mixture of ionic compounds.

5 (a) Name the particles which carry the electric current through:

5 (a) (i) the metal wires.....

(1 mark)

5 (a) (ii) the solution. .....

(1 mark)

5 (b) The table shows the ions in the solution.

Positive ions in the solution	Negative ions in the solution
Zinc ion (Zn^{2+})	Chloride ion (Cl^-)
Iron(III) ion (Fe^{3+})	Hydroxide ion (OH^-)
Hydrogen ion (H^+)	Nitrate ion (NO_3^-)
Copper(II) ion (Cu^{2+})	Sulfate ion (SO_4^{2-})

The reactivity series on the Data Sheet may help you to answer this question.

5 (b) (i) Which element is most likely to be formed at the negative electrode?

.....

(1 mark)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 33 · continued

5 (b) (ii) Explain, as fully as you can, why you have chosen this element.

.....

.....

.....

.....

(2 marks)

5 (c) The electrolysis of sodium chloride solution is an industrial process.

5 (c) (i) The reaction at one of the electrodes can be represented by the equation shown below.

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

The chloride ions (Cl^-) are oxidised.

Explain why.

.....

.....

(1 mark)

5 (c) (ii) The reaction at the other electrode can be represented by an equation.

Complete and balance the equation for the reaction at the other electrode.

$$H^+ \rightarrow H_2$$

(1 mark)

7

4.3.1.1 Conservation of mass and balanced chemical equations

Question 34

June 2011 | CHY2H | Original Q6 | Legacy

6 Lead compounds have been used for thousands of years as colours in paint.



6 (a) A sample of a red oxide used in paint was found to contain 6.21 g of lead and 0.64 g of oxygen.

Calculate the empirical (simplest) formula of this compound.

You **must** show all your working to gain full marks.

Relative atomic masses: O = 16; Pb = 207.

.....

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.....

.....

(4 marks)

4.3.1.1 Conservation of mass and balanced chemical equations

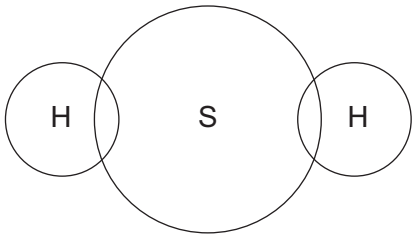
Question 34 · continued June 2011 | CHY2H | Original Q6 | Legacy

6 (b) A problem with lead compounds is that they slowly react with hydrogen sulfide in the air. This produces lead sulfide which is black.

6 (b) (i) Hydrogen sulfide has the formula H_2S. The bonding in a molecule of hydrogen sulfide can be represented as:

H–S–H

Complete the diagram below to show the arrangement of the outer electrons of the hydrogen and sulfur atoms in hydrogen sulfide.
Use dots (•) and crosses (x) to represent the electrons.
You need only show the outer shell electrons.
(Atomic numbers: H = 1; S = 16.)



(1 mark)

6 (b) (ii) Hydrogen sulfide has a low boiling point.

Explain why.

.....

.....

.....

.....

(2 marks)

6 (b) (iii) Lead white is also used in paint. The white colour slowly darkens when lead sulfide is produced.

The painting can be restored with hydrogen peroxide. This converts the black lead sulfide into white lead sulfate.

Balance the equation for the reaction between lead sulfide and hydrogen peroxide (H_2O_2).

$$PbS(s) + ...H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$$

(1 mark)

8

4.3.1.1 Conservation of mass and balanced chemical equations

Question 35

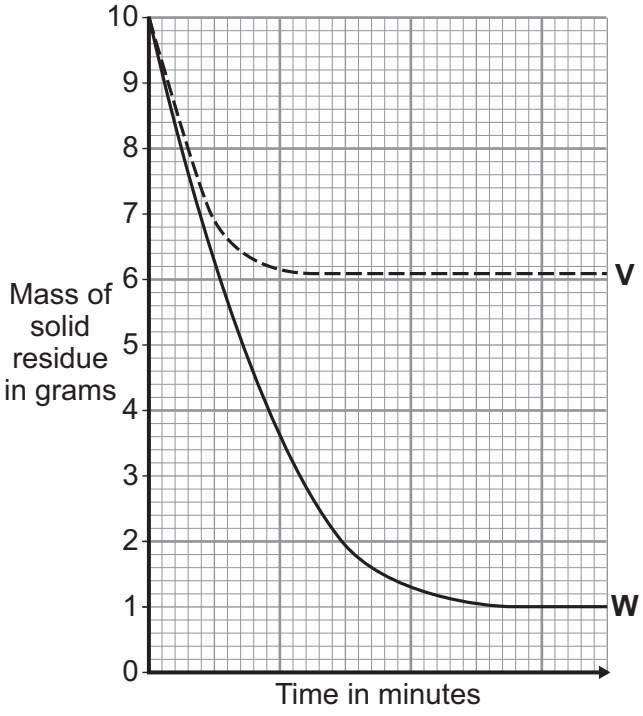
November 2011 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

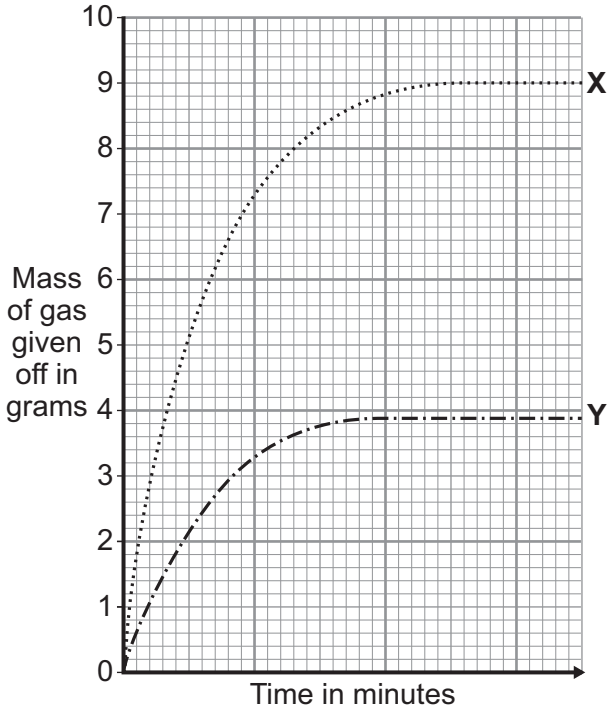
This question is about limestone and dolomite.

8A 10 g of limestone, which contained 10 % of an unreactive impurity, was heated strongly. The mass of the solid residue (**Graph 1**) and the mass of gas (**Graph 2**) given off were both recorded against time.

Graph 1



Graph 2



Which of the following lines on the graphs would be produced?

1 **V** and **X**

2 **V** and **Y**

3 **W** and **X**

4 **W** and **Y**

8B The formula for dolomite can be written as $CaMg(CO_3)_2$

What is the total number of atoms shown in this formula for dolomite?

1 4

2 7

3 10

4 12

4.3.1.1 Conservation of mass and balanced chemical equations

Question 35 · continued

8C Dolomite contains calcium carbonate and magnesium carbonate.

Magnesium carbonate decomposes when heated to temperatures above 540 °C.
Calcium carbonate decomposes when heated to temperatures above 900 °C.

Which row in the table correctly describes what happens when dolomite is heated to 750 °C?

	Calcium carbonate	Magnesium carbonate
1	No change	Undergoes reduction
2	Undergoes reduction	No change
3	No change	Undergoes thermal decomposition
4	Undergoes thermal decomposition	No change

8D Which of the following correctly completes and balances the equation for the total decomposition of dolomite?

$CaMg(CO_3)_2 \rightarrow$

1 $CaO + 2MgO + CO_2$

2 $CaO + Mg + 2CO_2$

3 $CaO + MgO + 2CO_2$

4 $Ca + Mg + 3CO_2$

4.3.1.1 Conservation of mass and balanced chemical equations

Question 36

January 2012 | CH1HP | Original Q4 | Legacy

4 Cans for food and drinks are made from steel or aluminium.
The main metal in steel is iron.



4 (a) Iron is extracted by heating a mixture of iron oxide and carbon in a blast furnace.

4 (a) (i) Name this type of reaction.

.....

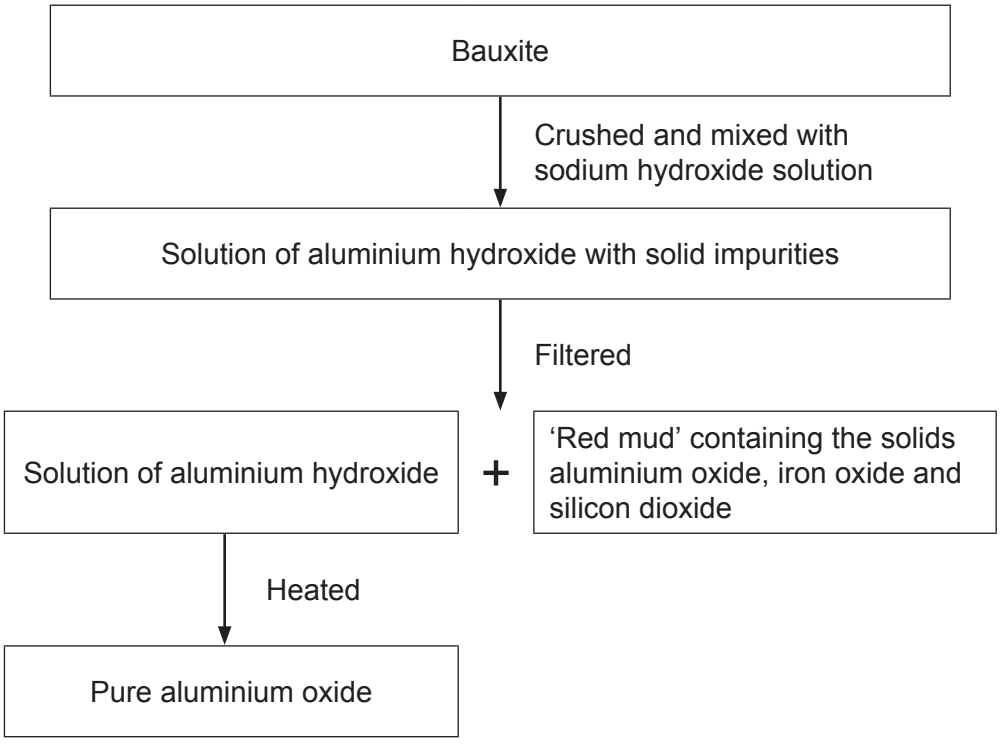
(1 mark)

4 (a) (ii) Balance the symbol equation for this reaction.

$2Fe_2O_3$ + ... C → ..... Fe + ... CO_2

(1 mark)

4 (b) Aluminium ore, bauxite, contains aluminium oxide, iron oxide and silicon dioxide.
Aluminium is extracted by electrolysis of aluminium oxide.



4.3.1.1 Conservation of mass and balanced chemical equations

Question 36 · continued

The 'red mud' which is dumped in very large ponds contains:

Name of solid	Percentage (%)
Aluminium oxide	10
Iron oxide	65
Silicon dioxide	25

4 (b) (i) 100 tonnes of bauxite produced 50 tonnes of pure aluminium oxide and 50 tonnes of 'red mud'.

What percentage of aluminium oxide did the bauxite contain?

.....

Answer = ... %

(1 mark)

4 (b) (ii) Apart from the solids shown in the table, name **one** other substance that would be in the 'red mud'.

.....

(1 mark)

4 (b) (iii) The purification of the aluminium oxide is usually done near to the bauxite quarries.

Suggest **one** reason why.

.....

(1 mark)

4 (c) Aluminium is used to make many things including cans.

During one year in the USA:
- 100 billion aluminium cans were sold
- 55 billion aluminium cans were recycled.

Give **one** environmental impact of recycling aluminium cans and **one** ethical or social impact of recycling aluminium cans.

Environmental .....

.....

Ethical or social .....

.....

(2 marks)

7

4.3.1.1 Conservation of mass and balanced chemical equations

Question 37

June 2012 | CH1HP | Original Q5 | Legacy

5 Calcium carbonate is found in limestone.
Limestone is used as a building material.
Limestone is also used to make calcium oxide and calcium hydroxide.

5 (a) Limestone is heated to make calcium oxide.

5 (a) (i) Calcium oxide reacts with a substance to produce calcium hydroxide.
Name the substance.

.....

(1 mark)

5 (a) (ii) Calcium hydroxide reacts with a substance to produce calcium carbonate.
Name the substance.

.....

(1 mark)

5 (b) Limestone reacts with acids.

5 (b) (i) Balance the chemical equation for the reaction of calcium carbonate with hydrochloric acid.

$$CaCO_3 + HCl \longrightarrow CaCl_2 + CO_2 + H_2O$$

(1 mark)

5 (b) (ii) Buildings made from limestone are affected by the products from burning fossil fuels containing sulfur.

Explain why.

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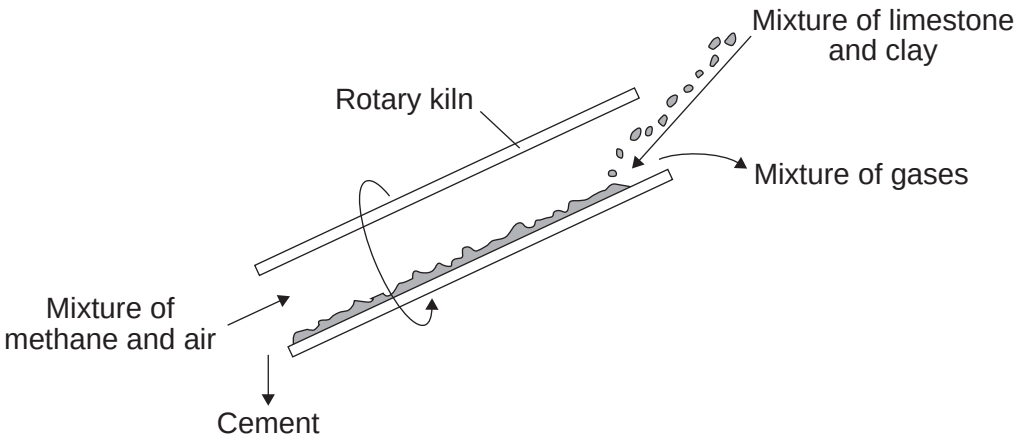
.....

(2 marks)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 37 · continued

5 (c) When a mixture of limestone and clay is heated in a rotary kiln cement is produced.
Burning a mixture of methane and air heats the kiln.
Clay does not decompose in the kiln.



5 (c) (i) Carbon dioxide is one of the main gases in the mixture of gases coming out of the kiln.

Give **two** reasons why.

.....

.....

.....

.....

(2 marks)

5 (c) (ii) Name the other main gas in the mixture of gases coming out of the kiln.

Give a reason why there is a high percentage of this gas in the mixture of gases coming out of the kiln.

Name of gas .....

Reason .....

.....

.....

(2 marks)

9

4.3.1.1 Conservation of mass and balanced chemical equations

Question 38

June 2012 | CH1HP | Original Q7 | Legacy

7 Ethanol (C_2H_5OH) is produced from ethene or from sugar cane.

The two different methods to produce ethanol are summarised in the table.

Ethanol from sugar cane is a batch process	Ethanol from crude oil is a continuous process
Sugar cane plants are crushed and soaked in water for one day.	Crude oil is distilled to separate the naphtha fraction.
The sugar solution is separated by filtration.	The naphtha fraction is cracked when the vaporised hydrocarbons are passed over a hot catalyst.
Yeast is added to the sugar solution and fermented for three days.	The ethene produced is separated by distillation.
The solution of water and ethanol produced is separated by filtration.	Ethene is reacted with steam in the presence of a catalyst.
Distillation of this solution produces a 50% solution of ethanol.	This hydration reaction produces 100% ethanol.

7 (a) Complete and balance an equation for the cracking of the hydrocarbon C_6H_{14} to produce ethene.

C_6H_{14} ⟶ ..... + ...

(2 marks)

7 (b) What is **seen** when the sugar solution and yeast are fermented?

.....

.....

(1 mark)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 38 · continued

7 (c) Evaluate the issues involved with the production of ethanol from sugar cane compared with the production of ethanol from crude oil.
You should explain why each issue you describe is important.

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(5 marks)

8

4.3.1.1 Conservation of mass and balanced chemical equations

Question 39

June 2012 | CH2HP | Original Q4 | Legacy

4 This question is about gold (Au).

4 (a) An atom of gold is represented as:

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

How many neutrons are in this atom of gold? .....

(1 mark)

4 (b) Gold ions are used as a catalyst.

How does a gold atom (Au) become a gold ion (Au^{3+})?

.....

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.....

.....

(2 marks)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 39 · continued June 2012 | CH2HP | Original Q4 | Legacy

4 (c) A gold catalyst can be used when carbon monoxide reacts with oxygen to make carbon dioxide.

4 (c) (i) Complete and balance the equation for this reaction.

..... CO + ... → ..... CO_2

(2 marks)

4 (c) (ii) Carbon dioxide has a very low boiling point.

Explain why.

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(3 marks)

4 (d) Gold is used as a catalyst in industrial processes. Gold is rare and increasingly expensive.

Suggest **three** reasons why gold is still used in industrial processes.

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(3 marks)

11

4.3.1.1 Conservation of mass and balanced chemical equations

Question 40

June 2012 | CH2HP | Original Q5 | Legacy

5 Aluminium is extracted from aluminium oxide.

5 (a) The formula of aluminium oxide is Al_2O_3

The relative formula mass (M_r) of aluminium oxide is 102.

Calculate the percentage of aluminium in aluminium oxide.

Relative atomic masses (A_r): O = 16; Al = 27.

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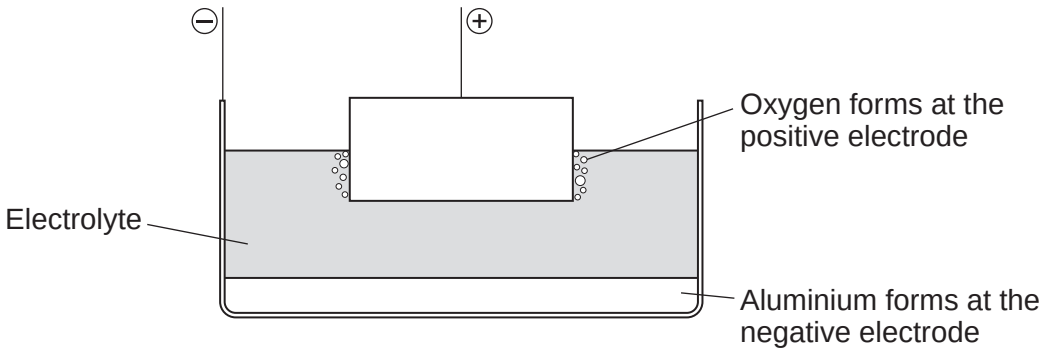
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Percentage of aluminium = ... %

(2 marks)

5 (b) Aluminium is extracted from aluminium oxide using electrolysis.

The diagram shows a cell used for the extraction of aluminium.



4.3.1.1 Conservation of mass and balanced chemical equations

Question 40 · continued

5 (b) (i) The electrolyte contains cryolite.

Explain why.

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.....

(2 marks)

5 (b) (ii) Oxygen is formed at the positive electrode. Complete and balance the equation for this reaction.

..... O^{2-} → O_2 + ...

(2 marks)

5 (b) (iii) The positive electrode in the cell is used up during the process.

Explain why.

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.....

(2 marks)

8

4.3.1.1 Conservation of mass and balanced chemical equations

Question 41

January 2013 | CH1HP | Original Q6 | Legacy

6 Most petrol used in cars contains about 5% ethanol (C_2H_5OH).

6 (a) The complete combustion of ethanol produces carbon dioxide and water.

Complete and balance the symbol equation for the complete combustion of ethanol.

C_2H_5OH + ...O_2 → ..... + ...

(2 marks)

6 (b) Ethanol can be produced from octane (C_8H_{18}).
The two chemical equations represent the production of ethanol from octane.

Equation 1: $C_8H_{18} \rightarrow C_4H_{10} + 2C_2H_4$

Equation 2: $C_2H_4 + H_2O \rightarrow C_2H_5OH$

6 (b) (i) In **Equation 1** the products are a mixture of two gases.

Describe a chemical test that would indicate the presence of ethene (C_2H_4) in the mixture.

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(2 marks)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 41 · continued

6 (b) (ii) Describe, as fully as you can, the conditions used for the two reactions to produce ethanol from octane.

Use **Equation 1** and **Equation 2** to help you with your answer.

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(4 marks)

8

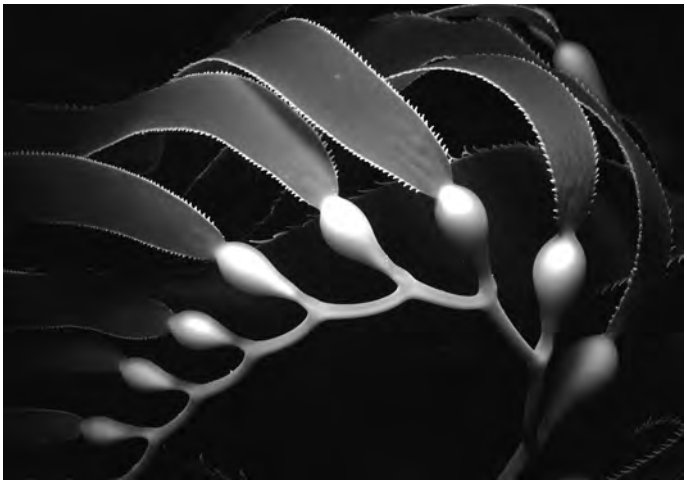
4.3.1.1 Conservation of mass and balanced chemical equations

Question 42

January 2013 | CH2HP | Original Q5 | Legacy

5 Kelp is a seaweed.

Kelp can be used in foods and as a renewable energy source.



5 (a) Scientific experiments, on their own, **cannot** fully answer one of the following questions. Which one?

Tick (✓) **one** box.

Questions	Tick (✓)
How much carbon dioxide is produced when 100 g of kelp is burned?	
Does kelp give out more heat energy than coal?	
Will kelp last longer than coal as an energy source?	
Which fuel, kelp or coal, produces the most ash when burned?	

(1 mark)

5 (b) Scientists cannot answer the question 'should people use kelp instead of coal as an energy source?'

Give **two** reasons why.

.....

.....

.....

.....

(2 marks)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 42 · continued

5 (c) Sodium iodide can be produced from kelp.

5 (c) (i) How many electrons are in the outer shell of an iodine atom?

(1 mark)

5 (c) (ii) Sodium iodide contains sodium ions (Na^+) and iodide ions (I^-).

Describe, as fully as you can, what happens when sodium atoms react with iodine atoms to produce sodium iodide.

You may use a diagram in your answer

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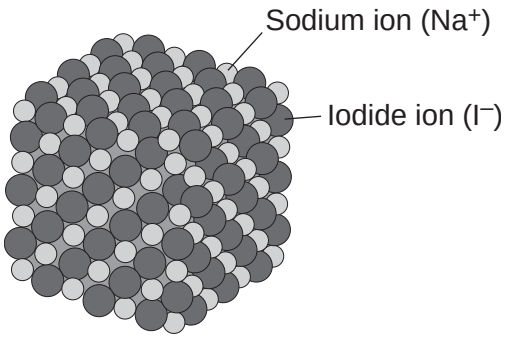
(3 marks)

Question 5 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

Question 42 · continued

5 (c) (iii) The diagram shows the structure of sodium iodide.



Solid sodium iodide does not conduct electricity.

Why does sodium iodide solution conduct electricity?

.....

.....

(1 mark)

5 (c) (iv) When sodium iodide solution is electrolysed, iodine is formed at the positive electrode.

Complete and balance the half equation for the formation of iodine.

..... I^- $\rightarrow$ I_2 + ... e^-

(1 mark)

5 (c) (v) What is formed at the negative electrode when sodium iodide solution is electrolysed?

Explain why.

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(2 marks)

11

4.3.1.1 Conservation of mass and balanced chemical equations

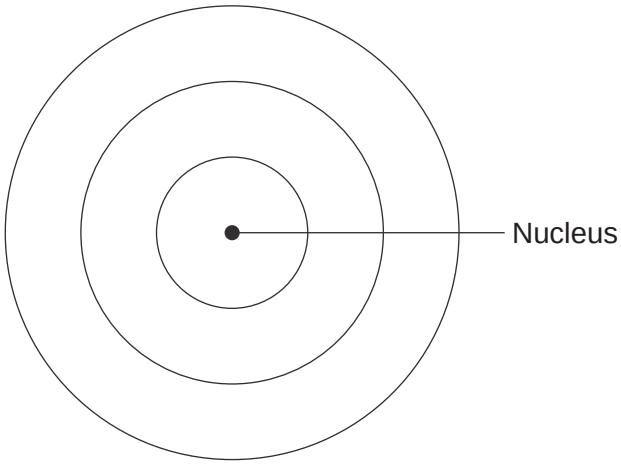
Question 43

June 2013 | CH1HP | Original Q1 | Legacy

1 Aluminium has many uses.

1 (a) An aluminium atom has 13 electrons.

1 (a) (i) Draw the electronic structure of an aluminium atom.



(1 mark)

1 (a) (ii) Name the **two** sub-atomic particles in the nucleus of an aluminium atom.

..... and .....

(1 mark)

1 (a) (iii) Why is there no overall electrical charge on an aluminium atom?

.....

.....

(1 mark)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 43 · continued

1 (b) Rail tracks are made from steel.

Molten iron is used to weld rail tracks.

The reaction of aluminium with iron oxide is used to produce molten iron.

1 (b) (i) Balance the chemical equation for the reaction.

.....Al + Fe_2O_3 ⟶ .....Fe + Al_2O_3

(1 mark)

1 (b) (ii) Why does aluminium react with iron oxide?

.....

.....

(1 mark)

5

Turn over for the next question

4.3.1.1 Conservation of mass and balanced chemical equations

Question 44

June 2013 | CH2HP | Original Q4 | Legacy

4 This question is about potassium.

4 (a) Humphrey Davy was a professor of chemistry.

In 1807 Davy did an electrolysis experiment to produce potassium.

4 (a) (i) Davy first tried to electrolyse a solid potassium salt to produce potassium.

Explain why this electrolysis did **not** work.

.....

.....

.....

.....

(2 marks)

4 (a) (ii) Humphrey Davy was the first person to produce potassium.

Humphrey Davy's experiment to produce this new element was quickly accepted by other scientists.

Suggest why.

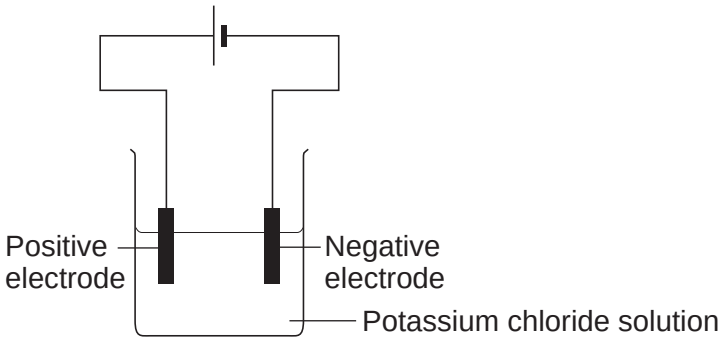
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(1 mark)

4 (b) A student dissolved some potassium chloride in water.
The student tried to electrolyse the potassium chloride solution to produce potassium.

The apparatus the student used is shown in the diagram.



4.3.1.1 Conservation of mass and balanced chemical equations

Question 44 · continued

The student expected to see potassium metal at the negative electrode, but instead saw bubbles of a gas.

- Name the gas produced at the negative electrode.
- Explain why this gas was produced at the negative electrode **and** why potassium was not produced.

The reactivity series of metals on the Chemistry Data Sheet may help you to answer this question.

.....

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(3 marks)

4 (c) The student tried to electrolyse molten potassium chloride to produce potassium.

4 (c) (i) Potassium metal was produced at the negative electrode.

Describe how potassium atoms are formed from potassium ions.

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(2 marks)

Question 4 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

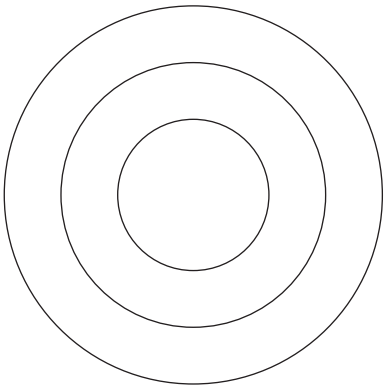
Question 44 · continued

4 (c) (ii) Complete and balance the equation for the reaction at the positive electrode.

.....Cl^- $\longrightarrow$ Cl_2 + ...

(1 mark)

4 (c) (iii) Complete the diagram to show the electronic structure of a chloride ion (Cl^-).



(1 mark)

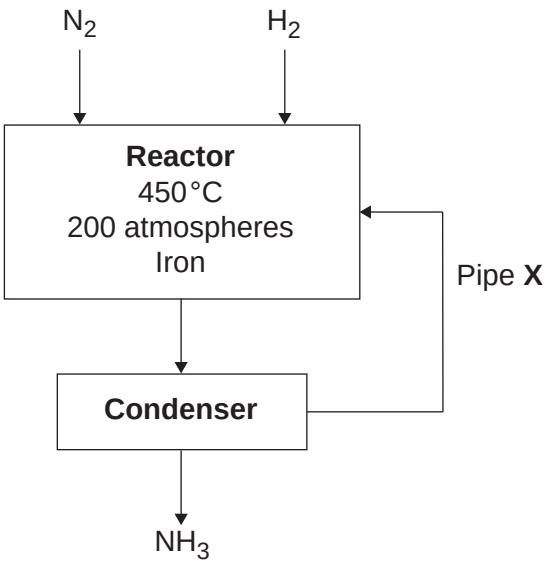
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4.3.1.1 Conservation of mass and balanced chemical equations

Question 45

June 2013 | CH3HP | Original Q6 | Legacy

6 The flow diagram shows the Haber process. In the Haber process, ammonia (NH_3) is produced from nitrogen (N_2) and hydrogen (H_2).



6 (a) Which raw material is nitrogen obtained from?

.....

(1 mark)

6 (b) What is the purpose of Pipe **X**?

.....

.....

.....

.....

(2 marks)

6 (c) Balance the chemical equation below for the production of ammonia.

N_2 + ...H_2 $\rightleftharpoons$ .....NH_3

(1 mark)

4.3.1.1 Conservation of mass and balanced chemical equations

Question 45 · continued

6 (d) A temperature of 450 °C is used in the reactor.
The reaction of nitrogen with hydrogen is reversible.
The forward reaction is exothermic.

Explain why a temperature of 450 °C is the optimum temperature for the Haber process.

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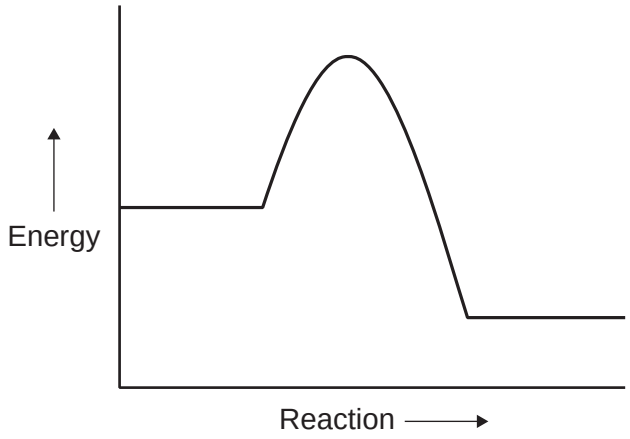
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(2 marks)

6 (e) An energy level diagram for the reaction between nitrogen and hydrogen is shown below.



6 (e) (i) How does the energy level diagram show this reaction is exothermic?

.....

.....

(1 mark)

6 (e) (ii) In the Haber process iron is used as a catalyst.

Draw a line on the energy level diagram to show the effect of adding a catalyst.

(1 mark)

8

4.3.1.1 Conservation of mass and balanced chemical equations

Question 46

June 2014 | CH1HP | Original Q4 | Legacy

4 Where copper ore has been mined there are areas of land that contain very low percentages of copper compounds.

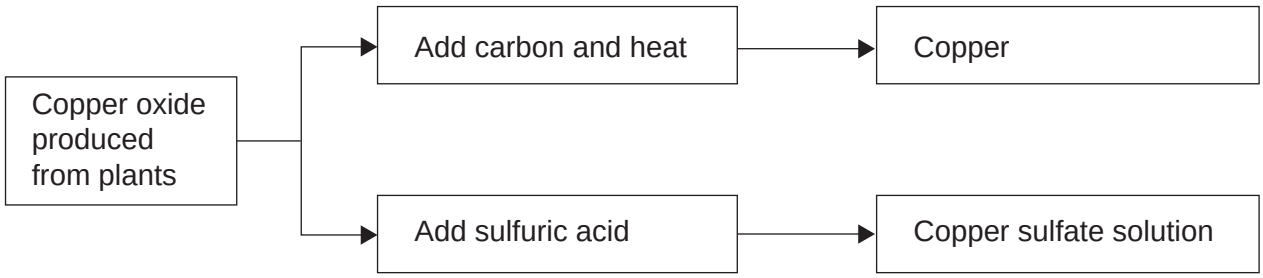
One way to extract the copper is to grow plants on the land.

The plants absorb copper compounds through their roots.

The plants are burned to produce copper oxide.

The copper oxide produced from plants can be reacted to produce copper or copper sulfate solution, as shown in **Figure 3**.

Figure 3



4 (a) (i) Complete the sentence.

[1 mark]

Using plants to extract metals is called ..... .

4 (a) (ii) Suggest **two** reasons why copper from these areas of land is **not** extracted by smelting.

[2 marks]

.....

.....

.....

.....

.....

4 (a) (iii) Complete and balance the chemical equation for the reaction of copper oxide with carbon.

[2 marks]

.....CuO + C ⟶ ..... + CO_2

4.3.1.1 Conservation of mass and balanced chemical equations

Question 46 · continued

4 (b) Copper is produced from copper sulfate solution by displacement using scrap iron or by electrolysis.

4 (b) (i) Use the Chemistry Data Sheet to help you to answer this question.

Give **two** reasons why scrap iron is used to displace copper.

[2 marks]

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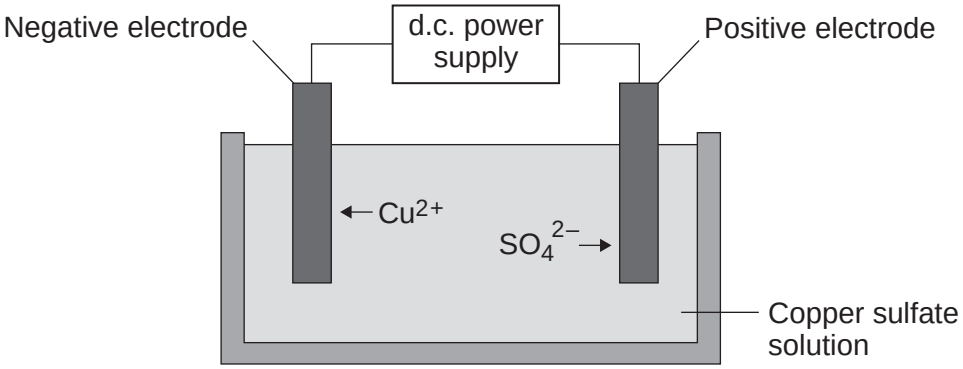
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4 (b) (ii) **Figure 4** shows the electrolysis of copper sulfate solution.

Figure 4



Describe what happens to the copper ions during electrolysis.

[2 marks]

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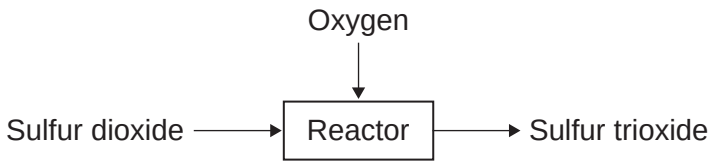
4.3.1.1 Conservation of mass and balanced chemical equations

Question 47

June 2014 | CH2HP | Original Q3 | Legacy

3 **Figure 2** represents a reaction in the production of sulfuric acid.

Figure 2



3 (a) Complete and balance the equation for the reaction.

[2 marks]

..... $SO_2(g)$ + ... (g) $\rightleftharpoons$ ..... $SO_3(g)$

3 (b) The conditions can affect the rate of the reaction.

3 (b) (i) The pressure of the reacting gases was increased.

State the effect of increasing the pressure on the rate of reaction.

Explain your answer in terms of particles.

[3 marks]

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4.3.1.1 Conservation of mass and balanced chemical equations

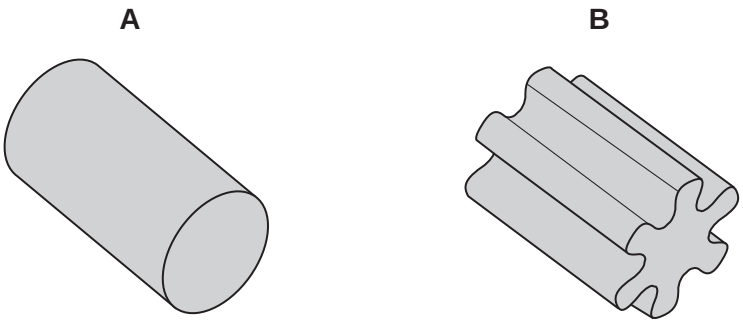
Question 47 · continued

3 (b) (ii) A catalyst is used for the reaction.

The gases pass through a layer containing pieces of the catalyst.

Figure 3 shows the shapes of pieces of catalyst.

Figure 3



Suggest and explain why shape **B** is more effective as a catalyst than shape **A**.

[2 marks]

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3 (c) The reaction is carried out at a high temperature to provide the reactants with the **activation energy**.

What is meant by the **activation energy**?

[1 mark]

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4.3.1.1 Conservation of mass and balanced chemical equations

Question 47 · continued

3 (d) Sulfuric acid reacts with metals to produce salts.

3 (d) (i) A student concluded that potassium would **not** be a suitable metal to react with sulfuric acid.

Explain why.

[2 marks]

.....

.....

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.....

3 (d) (ii) A student reacted zinc metal with sulfuric acid to produce a salt and another product.

Complete the equation for this reaction.

[2 marks]

$Zn + H_2SO_4 \longrightarrow$ ..... + ...

3 (d) (iii) The student wanted to increase the rate of the reaction between the zinc and sulfuric acid.

State **one** way, other than using a catalyst, that the student could increase the rate of the reaction.

[1 mark]

.....

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13

4.3.1.1 Conservation of mass and balanced chemical equations

Question 48

June 2014 | CH3HP | Original Q5 | Legacy

5 In 1909 Fritz Haber invented a process to produce ammonia from nitrogen and hydrogen.

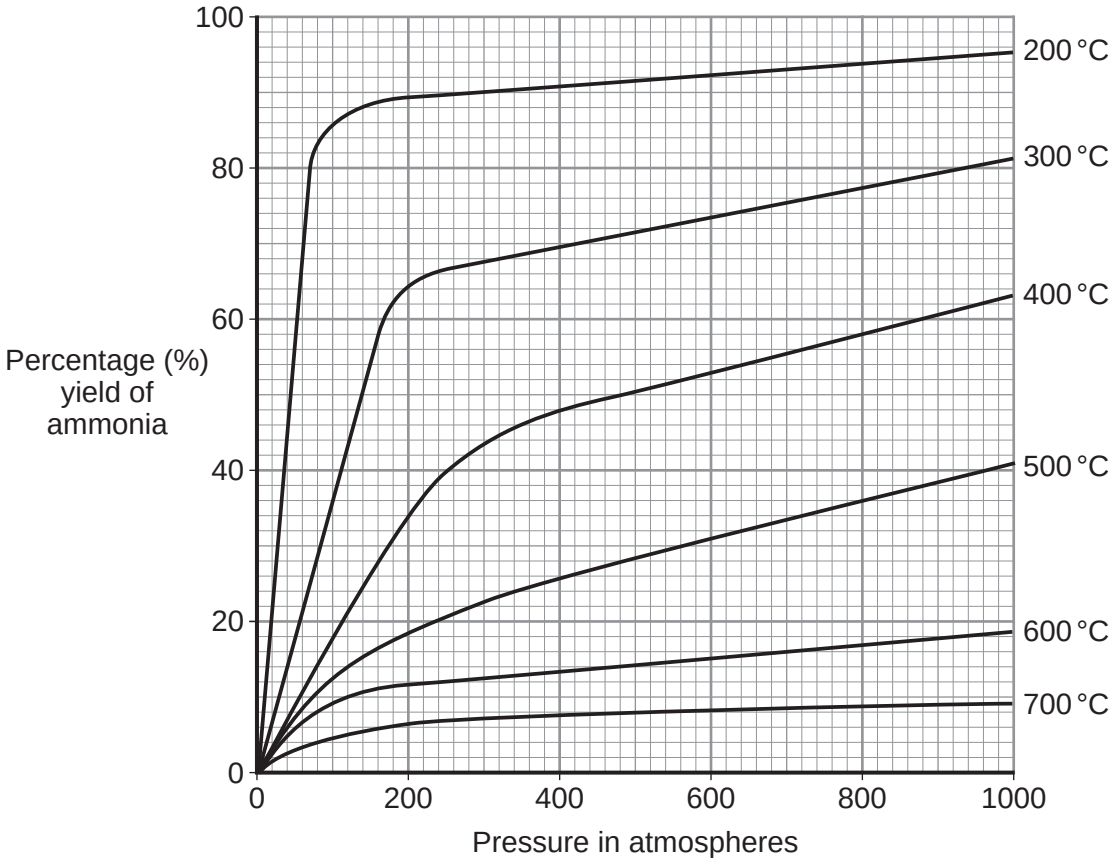
5 (a) Complete and balance the chemical equation for the production of ammonia from nitrogen and hydrogen.

[2 marks]

$$N_2 \quad + \quad 3H_2 \quad \rightleftharpoons \quad .....$$

5 (b) **Figure 5** shows how the equilibrium yield of ammonia changes with pressure at different temperatures.

Figure 5



5 (b) (i) Use the information in **Figure 5** to complete the sentence.

[1 mark]

The temperature on the graph that gives the highest yield of ammonia is ..... °C.

5 (b) (ii) The temperature used in the Haber process for the production of ammonia is 450 °C.

Why is a temperature much lower than 450 °C **not** used for the Haber process?

[1 mark]

.....

.....

4.3.1.1 Conservation of mass and balanced chemical equations

Question 48 · continued

5 (b) (iii) Use the information in **Figure 5** to answer this question.

Draw a ring around the pressure that gives the highest yield of ammonia.

[1 mark]

100 **200** **300** **400**

5 (b) (iv) The pressure used in the Haber process for the production of ammonia is 200 atmospheres.

Why is a pressure lower than 200 atmospheres **not** used for the Haber process?

[1 mark]

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5 (c) Explain how ammonia is separated from unreacted nitrogen and hydrogen in the Haber process.

[2 marks]

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4.3.1.1 Conservation of mass and balanced chemical equations

Question 49

June 2015 | CH2HP | Original Q5 | Legacy

5 This question is about compounds.

5 (a) **Table 2** gives information about the solubility of some compounds.

Table 2

Soluble compounds
All potassium and sodium salts
All nitrates
Chlorides, bromides and iodides, except those of silver and lead

Use information from **Table 2** to answer these questions.

5 (a) (i) Name a soluble compound that contains silver ions.

[1 mark]

.....

5 (a) (ii) Name a soluble compound that contains carbonate ions.

[1 mark]

.....

5 (b) Metal oxides react with acids to make salts.

What type of compound is a metal oxide?

[1 mark]

.....

4.3.1.1 Conservation of mass and balanced chemical equations

Question 49 · continued

5 (c) Lead nitrate solution is produced by reacting lead oxide with nitric acid.

5 (c) (i) State how solid lead nitrate can be obtained from lead nitrate solution.

[1 mark]

.....

.....

5 (c) (ii) Balance the equation for the reaction.

[1 mark]

$$PbO \quad + \quad HNO_3 \quad \longrightarrow \quad Pb(NO_3)_2 \quad + \quad H_2O$$

5 (c) (iii) Give the total number of atoms in the formula $Pb(NO_3)_2$

[1 mark]

.....

5 (d) An oxide of lead that does **not** have the formula PbO contains 6.21 g of lead and 0.72 g of oxygen.

Calculate the empirical formula of this lead oxide.

Relative atomic masses (A_r): O = 16; Pb = 207

You must show your working to gain full marks.

[4 marks]

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.....

Empirical formula = ...

10

4.3.1.1 Conservation of mass and balanced chemical equations

Question 50

June 2016 | CH1HP | Original Q3 | Legacy

3 Metals are extracted from ores in the Earth's crust.

Some ores contain metal carbonates and some ores contain metal oxides.

3 (a) (i) Name the type of reaction that happens when a metal carbonate is heated.

[1 mark]

_____

3 (a) (ii) Which solid product is formed when copper carbonate is heated?

[1 mark]

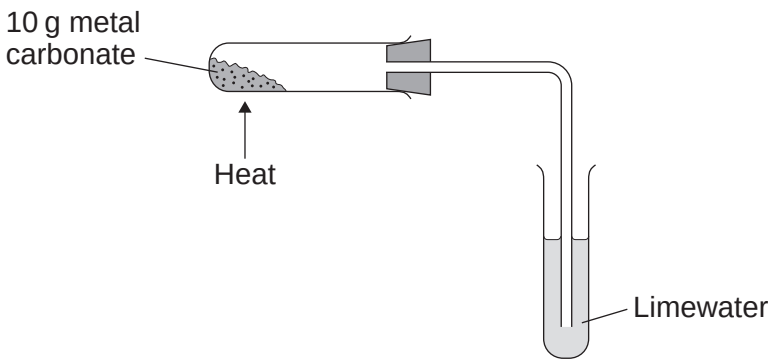
Tick (✓) **one** box.

- copper ☐
- copper nitrate ☐
- copper oxide ☐
- copper sulfide ☐

3 (b) A student investigated heating four metal carbonates.

Figure 4 shows the apparatus used.

Figure 4



4.3.1.1 Conservation of mass and balanced chemical equations

Question 50 · continued

The student heated each metal carbonate for five minutes.

Table 3 shows the results.

Table 3

Metal carbonate	Mass of metal carbonate at start in g	Mass of solid after heating for 5 minutes in g	Observations
Copper carbonate	10.0	6.9	Limewater turns cloudy
Magnesium carbonate	10.0	9.1	Limewater turns cloudy
Potassium carbonate	10.0	10.0	Limewater does not turn cloudy
Zinc carbonate	10.0	8.3	Limewater turns cloudy

3 (b) (i) Explain the results for potassium carbonate.

[3 marks]

3 (b) (ii) Suggest how the reactivity series can be used to predict which metal carbonate reacts most easily when heated.

[2 marks]

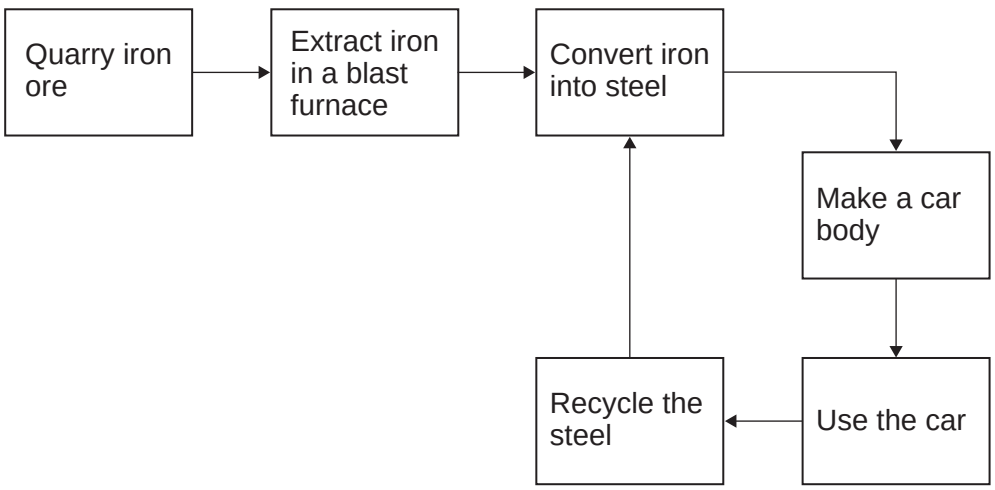
Question 3 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

Question 50 · continued

3 (c) **Figure 5** shows a simple life cycle of a car body.

Figure 5



3 (c) (i) Complete the sentence.

[1 mark]

Iron ores must contain enough iron to _____

_____

3 (c) (ii) Some iron ores contain iron oxide (Fe_2O_3).

Complete and balance the equation for a reaction to produce iron from iron oxide.

[2 marks]

_____ Fe_2O_3 + _____ C ⟶ _____ + _____ CO_2

3 (c) (iii) Give **two** reasons why iron produced in a blast furnace is converted into steel.

[2 marks]

_____

_____

_____

_____

4.3.1.1 Conservation of mass and balanced chemical equations

Question 50 · continued

3 (c) (iv) When a car reaches the end of its useful life, the car body can be:

- recycled
- reused
- sent to landfill.

Give **three** reasons why a steel car body should be recycled and **not** reused or sent to landfill.

[3 marks]

15

4.3.1.1 Conservation of mass and balanced chemical equations

Question 51

June 2016 | CH2HP | Original Q5 | Legacy

5 This question is about magnesium and magnesium chloride.

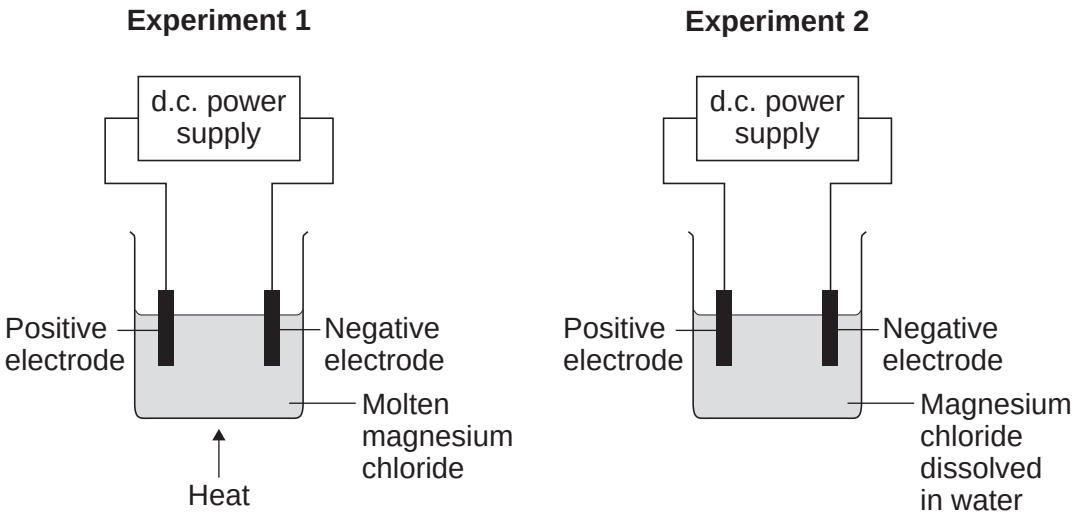
5 (a) Magnesium chloride contains magnesium ions (Mg^{2+}) and chloride ions (Cl^-).

Describe, in terms of electrons, what happens when a magnesium atom reacts with chlorine atoms to produce magnesium chloride.

[4 marks]

5 (b) Magnesium chloride can be electrolysed.
Figure 5 shows two experiments for electrolysing magnesium chloride.

Figure 5



4.3.1.1 Conservation of mass and balanced chemical equations

Question 51 · continued

5 (b) (i) Explain why magnesium chloride must be molten or dissolved in water to be electrolysed.

[2 marks]

5 (b) (ii) Explain how magnesium is produced at the negative electrode in **Experiment 1**.

[3 marks]

5 (b) (iii) In **Experiment 2** a gas is produced at the negative electrode.
Name the gas produced at the negative electrode.

[1 mark]

5 (b) (iv) Suggest why magnesium is **not** produced at the negative electrode in **Experiment 2**.

[1 mark]

Question 5 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

Question 51 · continued

5 (b) (v) Complete and balance the half equation for the reaction at the positive electrode.

[1 mark]



5 (c) Magnesium is a metal.
Explain why metals can be bent and shaped.

[2 marks]

14

4.3.1.1 Conservation of mass and balanced chemical equations

Question 52

June 2016 | CH3HP | Original Q5 | Legacy

5 This question is about energy changes in chemical reactions.

5 (a) Balance the chemical equation for the combustion of methane.

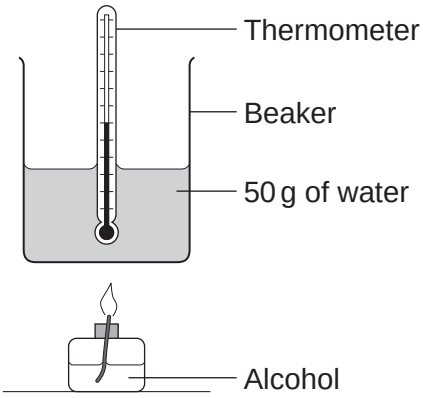
[1 mark]

$$CH_4 \quad + \quad O_2 \quad \longrightarrow \quad CO_2 \quad + \quad H_2O$$

5 (b) Alcohols are used as fuels.

A group of students investigated the amount of energy released when an alcohol was burned. The students used the apparatus shown in **Figure 5**.

Figure 5



In one experiment the temperature of 50 g of water increased from 22.0 °C to 38.4 °C. The mass of alcohol burned was 0.8 g.

Calculate the heat energy (Q) in joules, released by burning 0.8 g of the alcohol.
Use the equation:

$$Q = m \times c \times \Delta T$$

Specific heat capacity (c) = 4.2 J/g/°C

[3 marks]

Heat energy (Q) = _____ J

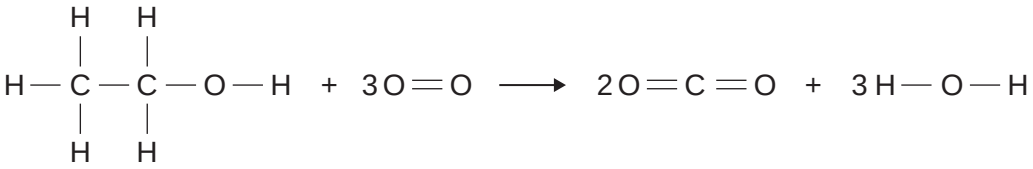
4.3.1.1 Conservation of mass and balanced chemical equations

Question 52 · continued

5 (c) The chemical equation for the combustion of ethanol is:

$$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$$

5 (c) (i) The equation for the reaction can be shown as:



Bond	Bond energy in kJ per mole
C — H	413
C — C	347
C — O	358
C = O	799
O — H	467
O = O	495

Use the bond energies to calculate the overall energy change for this reaction.

[3 marks]

Overall energy change = _____ kJ per mole

Question 5 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

Question 52 · continued

5 (c) (ii) The reaction is exothermic.
Explain why, in terms of bonds broken and bonds formed.

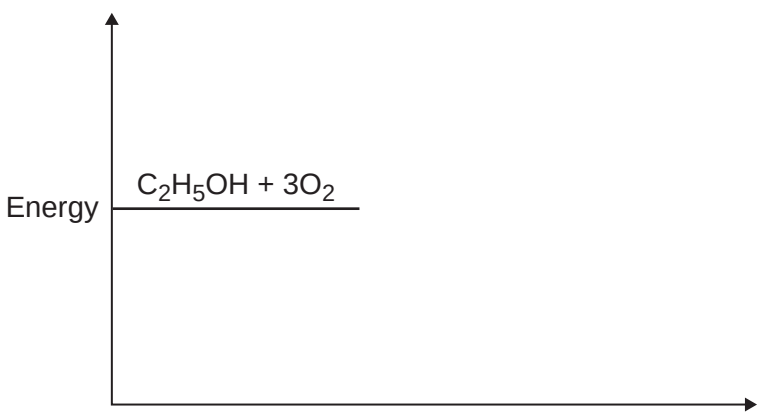
[2 marks]

5 (c) (iii) Complete the energy level diagram for the combustion of ethanol.

[3 marks]

On the completed diagram, label:

- activation energy
- overall energy change.



12

4.3.1.1 Conservation of mass and balanced chemical equations

Question 53

June 2017 | CH2HP | Original Q3 | Legacy

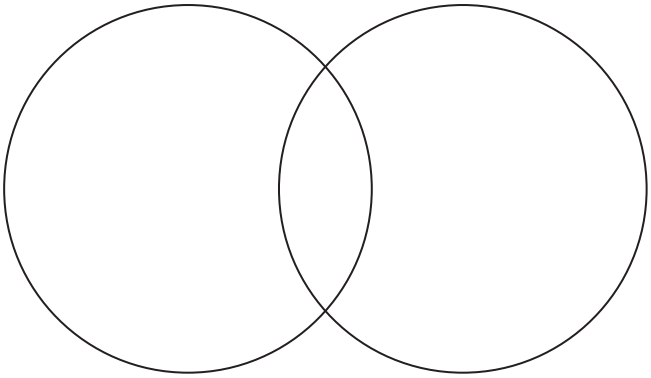
3 This question is about oxygen and substances containing oxygen.

3 (a) (i) Complete **Figure 4** to show the arrangement of the outer shell electrons in an oxygen molecule.

Use dots (•) and crosses (×) to represent the electrons.

[2 marks]

Figure 4



3 (a) (ii) Name the type of bonding in an oxygen molecule.

[1 mark]

_____

3 (a) (iii) Explain why oxygen has a low boiling point.

[2 marks]

_____

_____

_____

_____

4.3.1.1 Conservation of mass and balanced chemical equations

Question 53 · continued

3 (b) Magnesium oxide is produced when oxygen reacts with magnesium.

3 (b) (i) **Balance** the equation for the reaction.

[1 mark]

$$Mg + O_2 \longrightarrow MgO$$

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

Describe what happens, in terms of electrons, when magnesium atoms react with oxygen atoms to produce magnesium oxide.

[3 marks]

3 (b) (iii) Magnesium oxide nanoparticles can be made.

What are nanoparticles?

[1 mark]

Question 3 continues on the next page

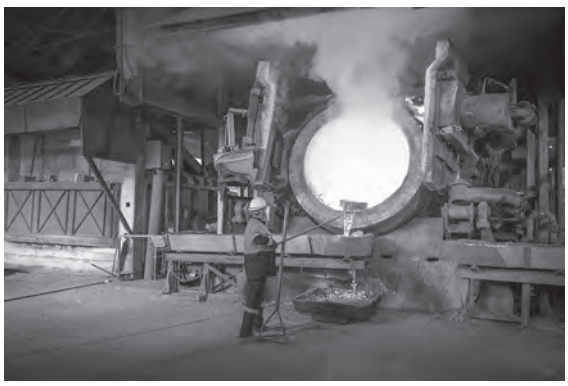
4.3.1.1 Conservation of mass and balanced chemical equations

Question 53 · continued

3 (c) **Figure 5** shows a furnace lined with silicon dioxide (SiO_2).

The temperature in the furnace is 1500 °C.

Figure 5



Explain, in terms of structure and bonding, why silicon dioxide is used to line furnaces.

[3 marks]

13

4.3.1.1 Conservation of mass and balanced chemical equations

Question 54

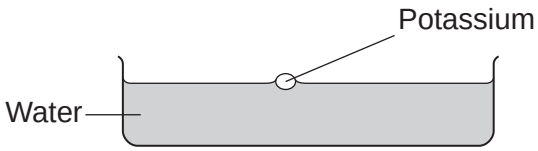
June 2017 | CH3HP | Original Q4 | Legacy

4 This question is about potassium and its compounds.

4 (a) (i) Potassium reacts with water to produce potassium hydroxide solution and a gas.

Figure 8 shows the apparatus used for the reaction.

Figure 8



Complete and balance the equation for the reaction.

[2 marks]

____ K + ____ H_2O ⟶ ____ KOH + _____

4 (a) (ii) Potassium and lithium are in Group 1 of the periodic table.

Give **two** differences you would see between the reactions of potassium and lithium with water.

[2 marks]

_____

_____

_____

_____

4.3.1.1 Conservation of mass and balanced chemical equations

Question 54 · continued

4 (b) Describe how a student could do titrations to find the mean volume of potassium hydroxide solution which would neutralise 25.00 cm^3 of nitric acid.

[5 marks]

4 (c) The student found that 26.25 cm^3 of potassium hydroxide solution with a concentration of 0.20 moles per dm^3 neutralises 25.00 cm^3 of nitric acid.

The equation for the reaction is:

$$KOH + HNO_3 \longrightarrow KNO_3 + H_2O$$

Calculate the concentration of the nitric acid.

[3 marks]

Concentration of nitric acid = _____ moles per dm^3

12

4.3.1.1 Conservation of mass and balanced chemical equations

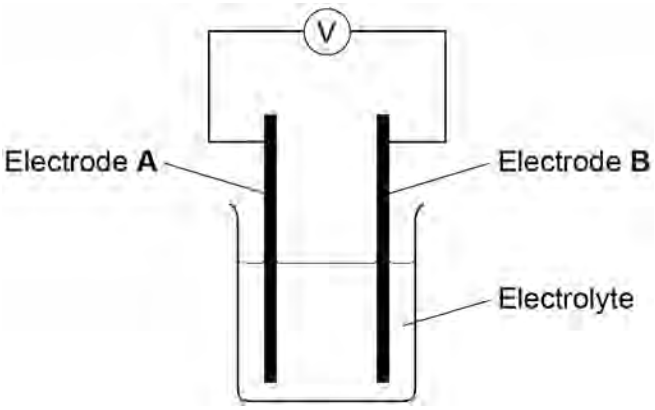
Question 55

June 2018 | 8462/1H | Original Q3

0 3 Chemical reactions can produce electricity.

0 3 . 1 **Figure 2** shows a simple cell.

Figure 2



Which of these combinations would **not** give a zero reading on the voltmeter in **Figure 2**?

[1 mark]

Tick **one** box.

Electrode A	Electrode B	Electrolyte	
Copper	Copper	Sodium chloride solution	☐
Zinc	Zinc	Water	☐
Copper	Zinc	Sodium chloride solution	☐
Copper	Zinc	Water	☐

4.3.1.1 Conservation of mass and balanced chemical equations

Question 55 · continued

Alkaline batteries are non-rechargeable.

0 3 . 2 Why do alkaline batteries eventually stop working?

[1 mark]

0 3 . 3 Why can alkaline batteries **not** be recharged?

[1 mark]

Question 3 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

Question 55 · continued

Hydrogen fuel cells and rechargeable lithium-ion batteries can be used to power electric cars.

0 3 . 4 Complete the balanced equation for the overall reaction in a hydrogen fuel cell.

[2 marks]

$$_____\ H_2 + _____ \rightarrow _____\ H_2O$$

0 3 . 5 **Table 1** shows data about different ways to power electric cars.

Table 1

	Hydrogen fuel cell	Rechargeable lithium-ion battery
Time taken to refuel or recharge in minutes	5	30
Distance travelled before refuelling or recharging in miles	Up to 415	Up to 240
Distance travelled per unit of energy in km	22	66
Cost of refuelling or recharging in £	50	3
Minimum cost of car in £	60 000	18 000

Evaluate the use of hydrogen fuel cells compared with rechargeable lithium-ion batteries to power electric cars.

Use **Table 1** and your own knowledge.

[6 marks]

4.3.1.1 Conservation of mass and balanced chemical equations

Question 55 · continued

June 2018 | 8462/1H | Original Q3

4.3.1.1 Conservation of mass and balanced chemical equations

Question 56

June 2019 | 8462/1H | Original Q7

0 7 This question is about electrolysis.

Aluminium is produced by electrolysing a molten mixture of aluminium oxide and cryolite.

0 7 . 1 Explain why a mixture is used as the electrolyte instead of using only aluminium oxide.

[2 marks]

0 7 . 2 What happens at the negative electrode during the production of aluminium?

[1 mark]

Tick (✓) **one** box.

- Aluminium atoms gain electrons. ☐
- Aluminium atoms lose electrons. ☐
- Aluminium ions gain electrons. ☐
- Aluminium ions lose electrons. ☐

0 7 . 3 Oxygen is produced at the positive electrode.

Complete the balanced half-equation for the process at the positive electrode.

[2 marks]

$\rightarrow \quad O_2 \quad +$

4.3.1.1 Conservation of mass and balanced chemical equations

Question 56 · continued

0 7 . 4 Explain why the positive electrode must be continually replaced.

[3 marks]

0 7 . 5 The overall equation for the electrolysis of aluminium oxide is:

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

Calculate the mass of oxygen produced when 2000 kg of aluminium oxide is completely electrolysed.

Relative atomic masses (A_r): O = 16 Al = 27

[4 marks]

Mass of oxygen = _____ kg

4.3.1.1 Conservation of mass and balanced chemical equations

Question 56 · continued

Sodium metal and chlorine gas are produced by the electrolysis of molten sodium chloride.

0 7 . 6 Explain why sodium chloride solution **cannot** be used as the electrolyte to produce sodium metal.

[2 marks]

0 7 . 7 Calculate the volume of 150 kg of chlorine gas at room temperature and pressure.

The volume of one mole of any gas at room temperature and pressure is 24.0 dm^3

Relative formula mass (M_r): Cl_2 = 71

[2 marks]

Volume = _____ dm^3

16

4.3.1.1 Conservation of mass and balanced chemical equations

Question 57

June 2019 | 8462/2H | Original Q5

0 5 This question is about combustion of fuels.

0 5 . 1 Some central heating boilers use wood as a fuel.

Suggest **two** reasons why wood is more sustainable than natural gas as a fuel for central heating boilers.

[2 marks]

1 _____

_____

2 _____

_____

Natural gas is mainly methane.

When methane burns it can produce both carbon monoxide and carbon dioxide.

0 5 . 2 Explain the process by which carbon monoxide can be produced when methane is burned.

[2 marks]

_____

_____

_____

_____

0 5 . 3 Balance the equation for the combustion of methane to produce carbon monoxide.

[1 mark]

$$___\ CH_4(g) + ___\ O_2(g) \rightarrow ___\ CO(g) + ___\ H_2O(l)$$

4.3.1.1 Conservation of mass and balanced chemical equations

Question 57 · continued

0 5 . 4 Propane burns to form carbon dioxide and water.

The equation for the reaction is:

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$$

3.60 dm^3 carbon dioxide is produced when a sample of propane is burned in 7.25 dm^3 oxygen.

Calculate the volume of unreacted oxygen.

Give your answer in cm^3

[4 marks]

Volume of unreacted oxygen = _____ cm^3

9

4.3.1.1 Conservation of mass and balanced chemical equations

Question 58

November 2020 | 8462/1H | Original Q3

0 3 This question is about silver iodide.

Silver iodide is produced in the reaction between silver nitrate solution and sodium iodide solution.

The equation for the reaction is:

$$AgNO_3(aq) + NaI(aq) \rightarrow AgI(s) + NaNO_3(aq)$$

0 3 . 1 A student investigated the law of conservation of mass.

This is the method used.

1. Pour silver nitrate solution into a beaker labelled **A**.
2. Pour sodium iodide solution into a beaker labelled **B**.
3. Measure the masses of both beakers and their contents.
4. Pour the solution from beaker **B** into beaker **A**.
5. Measure the masses of both beakers and their contents again.

Table 3 shows the student's results.

Table 3

	Mass before mixing in g	Mass after mixing in g
Beaker **A** and contents	78.26	108.22
Beaker **B** and contents	78.50	48.54

Explain how the results demonstrate the law of conservation of mass.

You should use data from **Table 3** in your answer.

[2 marks]

4.3.1.1 Conservation of mass and balanced chemical equations

Question 58 · continued

0 3 . 2 Suggest how the student could separate the insoluble silver iodide from the mixture at the end of the reaction.

[1 mark]

The student purified the separated silver iodide.

This is the method used.

1. Rinse the silver iodide with distilled water.

2. Warm the silver iodide.

0 3 . 3 Suggest **one** impurity that was removed by rinsing with water.

[1 mark]

0 3 . 4 Suggest why the student warmed the silver iodide.

[1 mark]

Question 3 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

Question 58 · continued

0 3 . 5 Calculate the percentage atom economy for the production of silver iodide in this reaction.

The equation for the reaction is:

$$AgNO_3(aq) + NaI(aq) \rightarrow AgI(s) + NaNO_3(aq)$$

Give your answer to 3 significant figures.

Relative formula masses (M_r): $AgNO_3 = 170$ NaI = 150 AgI = 235 $NaNO_3 = 85$

[4 marks]

Percentage atom economy (3 significant figures) = _____ %

0 3 . 6 Give **one** reason why reactions with a high atom economy are used in industry.

[1 mark]

10

4.3.1.1 Conservation of mass and balanced chemical equations

Question 59

November 2020 | 8462/1H | Original Q8

0 8 This question is about the halogens.

Table 5 shows the melting points and boiling points of some halogens.

Table 5

Element	Melting point in °C	Boiling point in °C
Fluorine	–220	–188
Chlorine	–101	–35
Bromine	–7	59

0 8 . 1 What is the state of bromine at 0 °C **and** at 100 °C?

[1 mark]

Tick (✓) **one** box.

State at 0 °C	State at 100 °C	
Gas	Gas	☐
Gas	Liquid	☐
Liquid	Gas	☐
Liquid	Liquid	☐
Solid	Gas	☐
Solid	Liquid	☐

4.3.1.1 Conservation of mass and balanced chemical equations

Question 59 · continued

0 8 . 2 Explain the trend in boiling points of the halogens shown in **Table 5**.

[4 marks]

0 8 . 3 Why is it **not** correct to say that the boiling point of a single bromine molecule is 59 °C?

[1 mark]

Question 8 continues on the next page

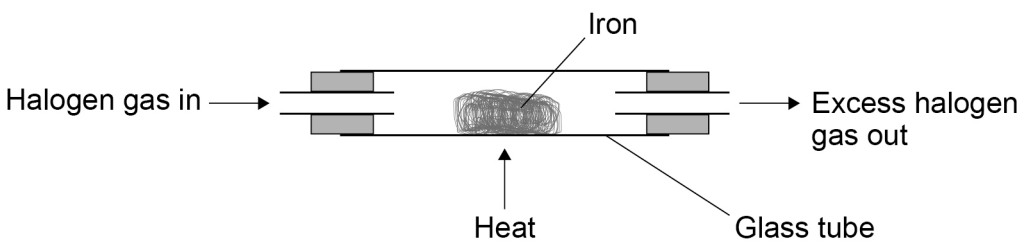
4.3.1.1 Conservation of mass and balanced chemical equations

Question 59 · continued

Iron reacts with each of the halogens in their gaseous form.

Figure 5 shows the apparatus used.

Figure 5



0 8 . 4 Give **one** reason why this experiment should be done in a fume cupboard.

[1 mark]

0 8 . 5 Explain why the reactivity of the halogens decreases going down the group.

[3 marks]

4.3.1.1 Conservation of mass and balanced chemical equations

Question 59 · continued

0 8 . 6 A teacher investigated the reaction of iron with chlorine using the apparatus in **Figure 5**.

The word equation for the reaction is:

iron + chlorine → iron chloride

The teacher weighed:

- the glass tube
- the glass tube and iron before the reaction
- the glass tube and iron chloride after the reaction.

Table 6 shows the teacher's results.

Table 6

	Mass in g
Glass tube	51.56
Glass tube and iron	56.04
Glass tube and iron chloride	64.56

Calculate the simplest whole number ratio of:

moles of iron atoms : moles of chlorine atoms

Determine the balanced equation for the reaction.

Relative atomic masses (A_r): Cl = 35.5 Fe = 56

[6 marks]

Moles of iron atoms : moles of chlorine atoms = _____ : _____

Equation for the reaction _____

16

4.3.1.1 Conservation of mass and balanced chemical equations

Question 60

November 2021 | 8462/1H | Original Q4

0 4 This question is about Group 1 elements.

0 4 . 1 Give **two** observations you could make when a small piece of potassium is added to water.

[2 marks]

1 _____

_____

2 _____

_____

0 4 . 2 Complete the equation for the reaction of potassium with water.

You should balance the equation.

[2 marks]

$$K + \qquad H_2O \rightarrow \qquad +$$

0 4 . 3 Explain why the reactivity of elements changes going down Group 1.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

_____

4.3.1.1 Conservation of mass and balanced chemical equations

Question 60 · continued

Sodium reacts with oxygen to produce the ionic compound sodium oxide.

Oxygen is a Group 6 element.

0 4 . 4 Draw a dot and cross diagram to show what happens when atoms of sodium and oxygen react to produce sodium oxide.

[4 marks]

Diagram

4.3.1.1 Conservation of mass and balanced chemical equations

Question 60 · continued

0 4 . 5 Why is oxygen described as being reduced in the reaction between sodium and oxygen?

[1 mark]

0 4 . 6 Explain why sodium oxide has a high melting point.

[3 marks]

16

4.3.1.1 Conservation of mass and balanced chemical equations

Question 61

November 2021 | 8462/1H | Original Q7

0 7 This question is about chemical reactions and electricity.

0 7 . 1 Electrolysis and chemical cells both involve chemical reactions and electricity.

Explain the difference between the processes in electrolysis and in a chemical cell.

[2 marks]

0 7 . 2 A teacher demonstrates the electrolysis of molten lead bromide.

Bromine is produced at the positive electrode.

Complete the half equation for the production of bromine.

You should balance the half equation.

[2 marks]

$$Br^- \rightarrow \quad + \quad$$

0 7 . 3 Two aqueous salt solutions are electrolysed using inert electrodes.

Complete **Table 4** to show the product at each electrode.

[3 marks]

Table 4

Salt solution	Product at positive electrode	Product at negative electrode
Copper nitrate		copper
Potassium iodide		

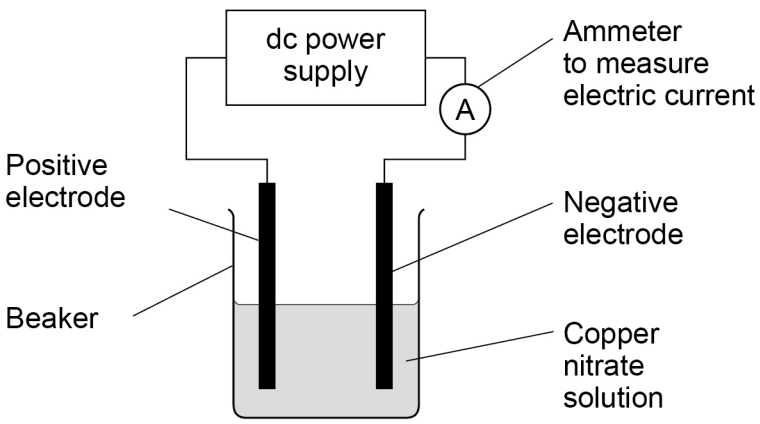
4.3.1.1 Conservation of mass and balanced chemical equations

Question 61 · continued

Some students investigated the electrolysis of copper nitrate solution using inert electrodes.

Figure 4 shows the apparatus.

Figure 4



The students investigated how the mass of copper produced at the negative electrode varied with:

- time
- current.

This is the method used.

1. Weigh the negative electrode.
2. Set up the apparatus shown in **Figure 4**.
3. Adjust the power supply until the ammeter shows a current of 0.3 A
4. Switch off the power supply after 5 minutes.
5. Rinse the negative electrode with water and allow to dry.
6. Reweigh the negative electrode.
7. Repeat steps 1 to 6 for different times.
8. Repeat steps 1 to 7 at different currents.

4.3.1.1 Conservation of mass and balanced chemical equations

Question 61 · continued

0 7 . 4 Some of the copper produced did not stick to the negative electrode but fell to the bottom of the beaker.

Suggest how the students could find the total mass of copper produced.

[4 marks]

Question 7 continues on the next page

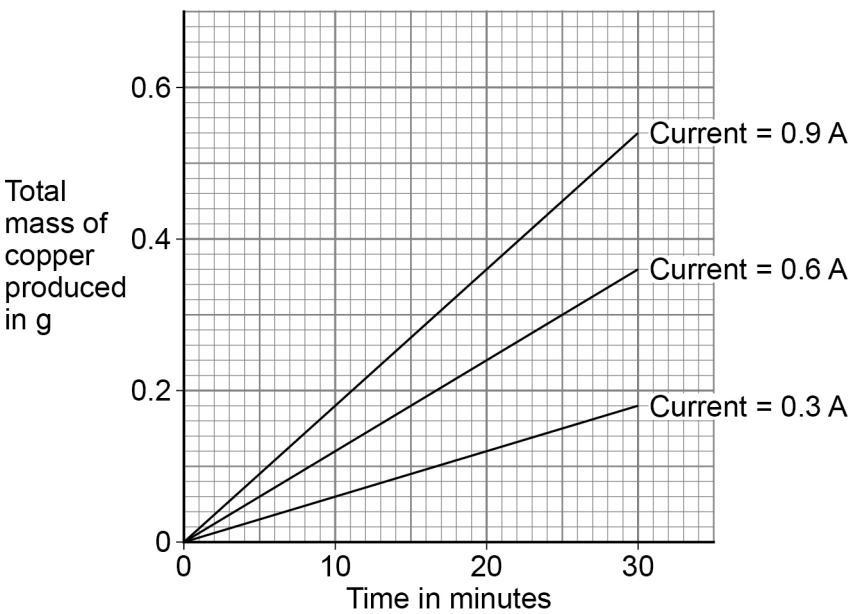
4.3.1.1 Conservation of mass and balanced chemical equations

Question 61 · continued

The students plotted their results on a graph.

Figure 5 shows the graph.

Figure 5



A student correctly concluded that the total mass of copper produced is directly proportional both to the time and to the current.

0 7 . 5 How do the results in **Figure 5** support the conclusion that the total mass of copper produced is directly proportional to the time?

[1 mark]

0 7 . 6 How do the results in **Figure 5** support the conclusion that the total mass of copper produced is directly proportional to the current?

Use data from **Figure 5** in your answer.

[1 mark]

4.3.1.1 Conservation of mass and balanced chemical equations

Question 61 · continued

0 7 . 7 Copper nitrate solution is blue.

Suggest why the blue colour of the copper nitrate solution fades during the electrolysis.

[1 mark]

0 7 . 8 Determine the number of atoms of copper produced when copper nitrate solution is electrolysed for 20 minutes at a current of 0.6 A

Give your answer to 3 significant figures.

Use **Figure 5**.

Relative atomic mass (A_r): Cu = 63.5

The Avogadro constant = 6.02×10^{23} per mole

[3 marks]

Number of atoms (3 significant figures) = _____

17

4.3.1.1 Conservation of mass and balanced chemical equations

Question 62

November 2021 | 8462/2H | Original Q10

1 0 This question is about alkenes and alcohols.

Ethene is an alkene produced from large hydrocarbon molecules.

Large hydrocarbon molecules are obtained from crude oil by fractional distillation.

1 0 . 1 Name the process used to produce ethene from large hydrocarbon molecules.

[1 mark]

1 0 . 2 Describe the conditions used to produce ethene from large hydrocarbon molecules.

[2 marks]

4.3.1.1 Conservation of mass and balanced chemical equations

Question 62 · continued

1 0 . 3 Ethanol can be produced from ethene and steam.

The equation for the reaction is:

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

The forward reaction is exothermic.

Explain how the conditions for this reaction should be chosen to produce ethanol as economically as possible.

[6 marks]

4.3.1.1 Conservation of mass and balanced chemical equations

Question 62 · continued

10.4 Ethanol can also be produced from sugar solution by adding yeast.

Name this process.

[1 mark]

10.5 Butanol can be produced from sugar solution by adding bacteria.

Sugar solution is broken down in similar ways by bacteria and by yeast.

Suggest the reaction conditions needed to produce butanol from sugar solution by adding bacteria.

[2 marks]

4.3.1.1 Conservation of mass and balanced chemical equations

Question 62 · continued

Ethanol and butanol can be used as fuels for cars.

10.6 A car needs an average of 1.95 kJ of energy to travel 1 m

Ethanol has an energy content of 1300 kilojoules per mole (kJ/mol).

Calculate the number of moles of ethanol needed by the car to travel 200 km

[3 marks]

Number of moles = _____ mol

10.7 When butanol is burned in a car engine, complete combustion takes place.

Write a balanced equation for the complete combustion of butanol.

You do **not** need to include state symbols.

[2 marks]

17

4.3.1.1 Conservation of mass and balanced chemical equations

Question 63

June 2022 | 8462/1H | Original Q5

0 5 This question is about groups in the periodic table.

The elements in Group 1 become more reactive going down the group.

Rubidium is below potassium in Group 1.

0 5 . 1 Rubidium and potassium are added to water.

Predict **one** observation you would see that shows that rubidium is more reactive than potassium.

[1 mark]

0 5 . 2 Explain why rubidium is more reactive than potassium.

[3 marks]

0 5 . 3 Complete the equation for the reaction of rubidium with water.

You should balance the equation.

[3 marks]

$$Rb + H_2O \rightarrow \quad +$$

4.3.1.1 Conservation of mass and balanced chemical equations

Question 63 · continued

The noble gases are in Group 0.

0 5 . 4 Which is a correct statement about the noble gases?

[1 mark]

Tick (✓) **one** box.

The noble gases all have atoms with eight electrons in the outer shell. ☐

The noble gases have boiling points that increase going down the group. ☐

The noble gases have molecules with two atoms. ☐

The noble gases react with metals to form ionic compounds. ☐

0 5 . 5 **Table 1** shows information about the three isotopes of neon.

Table 1

Mass number	Percentage abundance (%)
20	90.48
21	0.27
22	9.25

Calculate the relative atomic mass (A_r) of neon.

Give your answer to 3 significant figures.

[3 marks]

Relative atomic mass (3 significant figures) = _____

11

4.3.1.1 Conservation of mass and balanced chemical equations

Question 64

June 2022 | 8462/2H | Original Q4

0 4 This question is about the fractions obtained from crude oil.

0 4 . 1 Crude oil is separated into fractions by fractional distillation.

The fractions obtained from crude oil include:

- lubricating oil
- naphtha
- petroleum gases.

Table 3 shows the boiling point range of these fractions.

Table 3

Fraction	Boiling point range in °C
Lubricating oil	300–350
Naphtha	90–200
Petroleum gases	< 25

Explain how these fractions are obtained from crude oil by fractional distillation.

[4 marks]

4.3.1.1 Conservation of mass and balanced chemical equations

Question 64 · continued

0 4 . 2 Fractions from crude oil can be processed to produce feedstock for the petrochemical industry.

Which **two** are useful materials produced from this feedstock?

[2 marks]

Tick (✓) **two** boxes.

- Alloys ☐
- Ceramics ☐
- Detergents ☐
- Fertilisers ☐
- Solvents ☐

Another fraction obtained from crude oil is petrol.

0 4 . 3 Petrol contains a hydrocarbon with the formula C_9H_{20}

Complete the equation for the complete combustion of C_9H_{20}

You should balance the equation.

[2 marks]

C_9H_{20} + _____ → _____ + _____

0 4 . 4 Petrol obtained from crude oil contains sulfur impurities.

Explain why sulfur impurities are removed before petrol is burned in car engines.

[2 marks]

4.3.1.1 Conservation of mass and balanced chemical equations

Question 64 · continued

0 4 . 5 **Table 4** shows information about two more fractions obtained from crude oil.

Table 4

Fraction	Range of number of carbon atoms in each molecule
Kerosene	11–15
Heavy fuel oil	20–40

A student predicted that heavy fuel oil is more viscous than kerosene.

The student's prediction was correct.

Justify the student's prediction.

[2 marks]

4.3.1.1 Conservation of mass and balanced chemical equations

Question 64 · continued

The heavy fuel oil fraction can be processed to produce smaller hydrocarbon molecules.

0 4 . 6 Name the process which produces smaller hydrocarbon molecules from heavy fuel oil.

Give the conditions used in this process.

[3 marks]

Name of process _____

Conditions _____

_____

_____

0 4 . 7 Hydrocarbon molecules containing seven and eight carbon atoms can be produced when heavy fuel oil is processed.

Which pair of hydrocarbon molecules would **both** turn bromine water colourless?

[1 mark]

Tick (✓) **one** box.

C_7H_{14} and C_8H_{16} ☐

C_7H_{14} and C_8H_{18} ☐

C_7H_{16} and C_8H_{16} ☐

C_7H_{16} and C_8H_{18} ☐

16

4.3.1.1 Conservation of mass and balanced chemical equations

Question 65

June 2023 | 8462/1H | Original Q8

0 8 This question is about elements in the periodic table.

0 8 . 1 Argon has the atomic number 18

Explain why argon does **not** form compounds.

Answer in terms of electrons.

[2 marks]

0 8 . 2 Phosphorus (P) is the element below nitrogen in the periodic table.

Predict the formula of the compound formed between phosphorus and hydrogen.

[1 mark]

Formula = _____

0 8 . 3 Tellurium is the element with atomic number 52

Predict whether tellurium reacts with metals.

Explain your answer.

Answer in terms of the position of tellurium in the periodic table.

[2 marks]

4.3.1.1 Conservation of mass and balanced chemical equations

Question 65 · continued

Barium (Ba) is an element in Group 2 of the periodic table.

Barium reacts with hydrochloric acid.

0 8 . 4 Suggest **two** observations that could be made when barium reacts with hydrochloric acid.

[2 marks]

1 _____

_____

2 _____

_____

0 8 . 5 Write a balanced symbol equation for the reaction between barium and hydrochloric acid.

[3 marks]

_____ + _____ → _____ + _____

10

4.3.1.1 Conservation of mass and balanced chemical equations

Question 66

June 2023 | 8462/2H | Original Q5

0 5 Copper is extracted from metal ores.

Chalcopyrite is a metal ore containing a compound with the formula $CuFeS_2$

0 5 . 1 $CuFeS_2$ reacts with oxygen to produce copper(II) sulfate and iron(II) sulfate.

Complete the equation for this reaction.

You should balance the equation.

[2 marks]

$$CuFeS_2 \quad + \quad \underline{\qquad\qquad} \quad \rightarrow \quad CuSO_4 \quad + \quad FeSO_4$$

0 5 . 2 Calculate the percentage by mass of copper in $CuFeS_2$

Relative atomic masses (A_r): S = 32 Fe = 56 Cu = 63.5

[3 marks]

Percentage by mass = _____ %

0 5 . 3 Describe a test to show the presence of copper(II) ions in a solution of copper(II) sulfate.

Give the result of the test.

[2 marks]

Test _____

Result _____

4.3.1.1 Conservation of mass and balanced chemical equations

Question 66 · continued

0 5 . 4 Copper can be extracted from low-grade ores by bioleaching.

Describe what is meant by bioleaching.

[2 marks]

9

Turn over for the next question

4.3.1.1 Conservation of mass and balanced chemical equations

Question 67

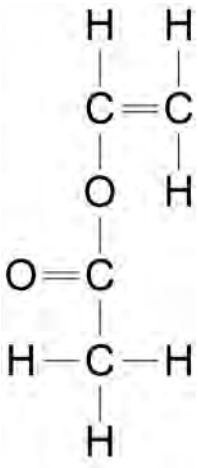
June 2024 | 8462/2H | Original Q8

0 8 This question is about monomers and polymers.

Compound **A** has an alkene functional group and an ester functional group.

Figure 8 represents a molecule of compound **A**.

Figure 8



0 8 . 1 Draw a circle around the alkene functional group on **Figure 8**.

[1 mark]

0 8 . 2 Describe what will be seen when compound **A** is shaken with bromine water.

[2 marks]

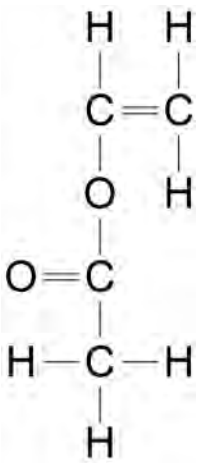
Question 8 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

Question 67 · continued

0 8 . 3 **Figure 9** is a repeat of **Figure 8**.

Figure 9



Draw a circle around the ester functional group on **Figure 9**.

[1 mark]

0 8 . 4 Compound **A** has the formula $C_4H_6O_2$

Compound **A** is flammable.

Write a balanced equation for the complete combustion of compound **A**.

[3 marks]

_____ + _____ → _____ + _____

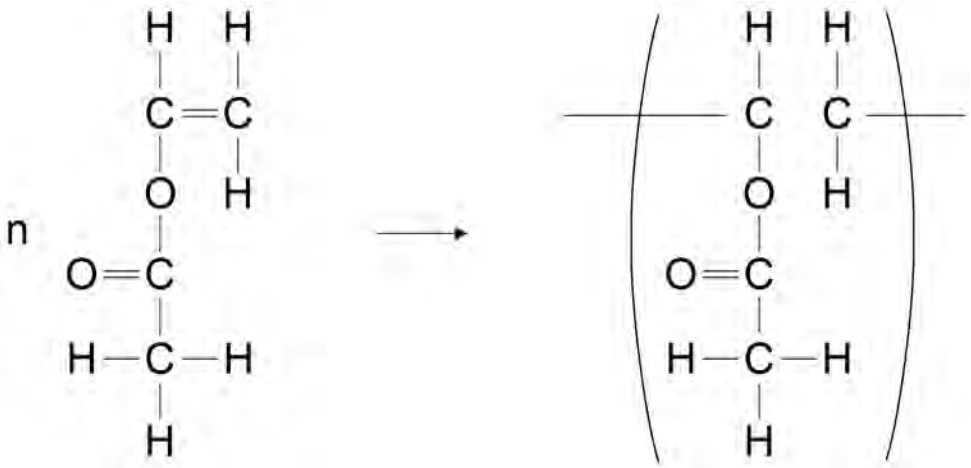
4.3.1.1 Conservation of mass and balanced chemical equations

Question 67 · continued

0 8 . 5 Many molecules of compound **A** join together to form polymer **B**.

Complete the displayed formula equation which represents this reaction.

[2 marks]



0 8 . 6 What type of polymer is polymer **B**?

[1 mark]

Tick (✓) **one** box.

- Addition polymer ☐
- Condensation polymer ☐
- DNA ☐
- Protein ☐

Question 8 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

Question 67 · continued

Polymer **B** is a polymer which melts when heated.

0 8 . 7 What word is used to describe polymers which melt when heated?

[1 mark]

0 8 . 8 Explain why some polymers do **not** melt when heated.

[2 marks]

13

4.3.1.1 Conservation of mass and balanced chemical equations

Question 68

June 2025 | 8462/1H | Original Q3

0 3 This question is about metals and metal oxides.

Tin (Sn) is extracted from tin oxide using carbon.

The equation for the reaction is:

$$SnO_2 + C \longrightarrow Sn + CO_2$$

0 3 . 1 Which substance is reduced in this reaction?

Give **one** reason for your answer.

Answer in terms of oxygen.

[2 marks]

Substance reduced _____

Reason _____

_____

0 3 . 2 Why can carbon be used to extract tin from tin oxide?

[1 mark]

_____

_____

Question 3 continues on the next page

4.3.1.1 Conservation of mass and balanced chemical equations

Question 68 · continued

0 3 . 3 Cadmium (Cd) can be extracted by the reaction of cadmium oxide with carbon.

The equation for the reaction is:

$$CdO + C \longrightarrow Cd + CO$$

Calculate the percentage atom economy for the production of cadmium in this reaction.

Relative atomic masses (A_r): C = 12 Cd = 112

Relative formula mass (M_r): CdO = 128

[3 marks]

Percentage atom economy = _____ %

0 3 . 4 Tungsten is a transition metal.

Potassium is a Group 1 metal.

Give **two** differences between the properties of tungsten and the properties of potassium.

[2 marks]

1 _____

2 _____

4.3.1.1 Conservation of mass and balanced chemical equations

Question 68 · continued

Tungsten oxide reacts with hydrogen to give tungsten (W) and water.

0 3 . 5 The equation for the reaction is:

$$WO_3 + 3\,H_2 \longrightarrow W + 3\,H_2O$$

The law of conservation of mass states:

'The mass of the products equals the mass of the reactants during a chemical reaction.'

Show that the equation obeys the law of conservation of mass.

Relative atomic mass (A_r): W = 184

Relative formula masses (M_r): H_2 = 2 WO_3 = 232 H_2O = 18

[2 marks]

0 3 . 6 The reaction producing tungsten has a high atom economy.

Why is it important to use reactions with a high atom economy in industry?

[1 mark]

11

4.3.1.1 Conservation of mass and balanced chemical equations

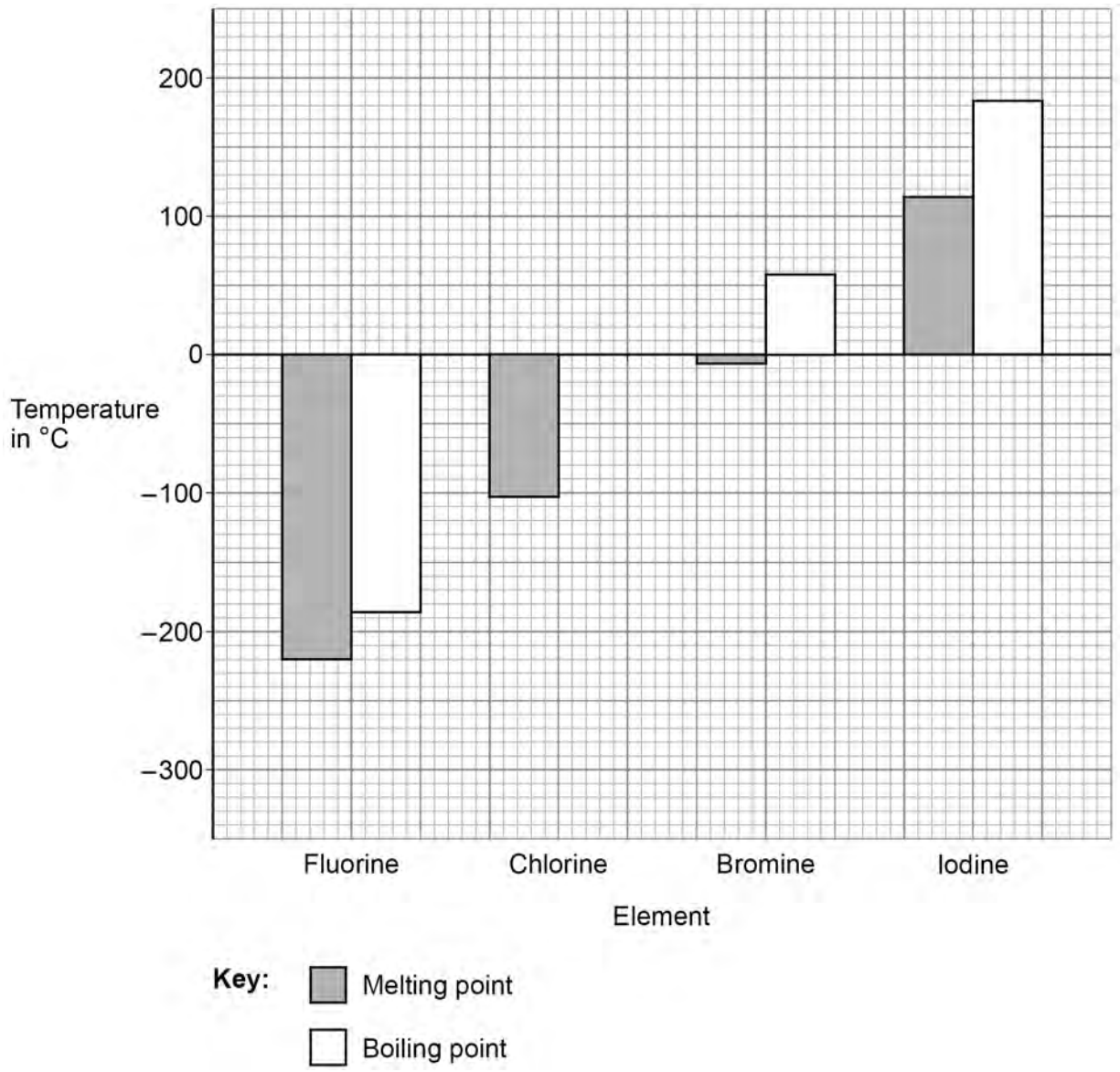
Question 69

June 2025 | 8462/1H | Original Q4

0 4 The elements in Group 7 of the periodic table are known as the halogens.

Figure 4 shows information about some of the elements in Group 7.

Figure 4



4.3.1.1 Conservation of mass and balanced chemical equations

Question 69 · continued

0 4 . 1 Predict the boiling point of chlorine.

Use **Figure 4**.

[1 mark]

_____ °C

0 4 . 2 What is the state of fluorine at –250 °C?

Use **Figure 4**.

[1 mark]

_____

Astatine (At) is an element in Group 7.

0 4 . 3 What is the number of electrons in the outer shell of an astatine atom?

[1 mark]

_____

0 4 . 4 Hydrogen reacts with astatine to produce hydrogen astatide.

Predict the formula of hydrogen astatide.

[1 mark]

_____

Question 4 continues on the next page

Question 69 · continued

0 4 . 5 Explain the trend in reactivity of the elements going down Group 7.

[4 marks]

Extra space

0 4 . 6 A more reactive halogen can displace a less reactive halogen from a solution of its salt.

Write a balanced equation for the reaction between bromine and potassium iodide.

[3 marks]

_____ + _____ ⟶ _____ + _____

11

4.3.1.1 Conservation of mass and balanced chemical equations

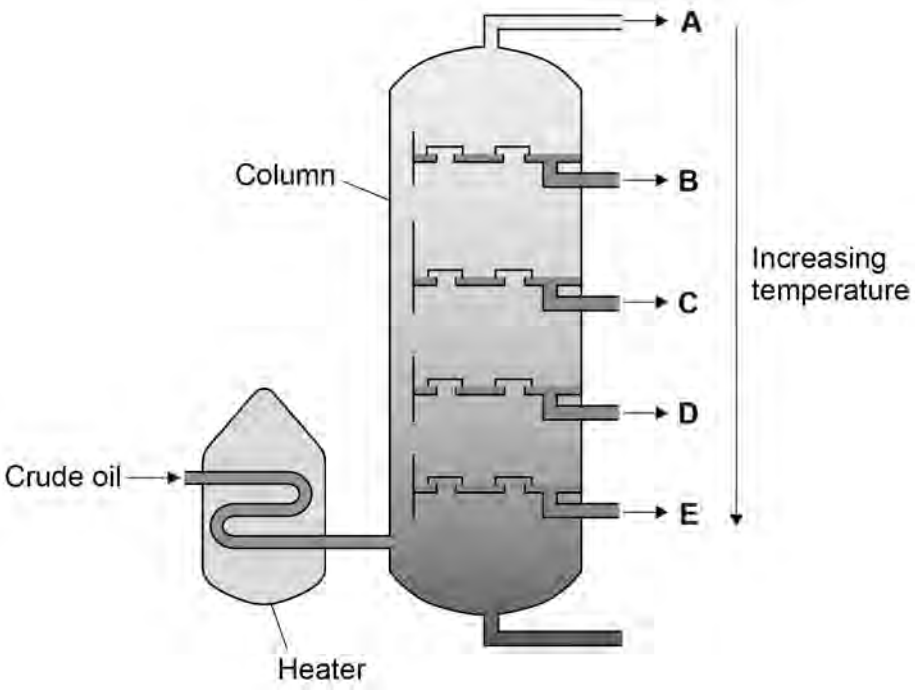
Question 70

June 2025 | 8462/2H | Original Q2

0 2 This question is about hydrocarbon fuels.

Figure 1 represents the process used to separate hydrocarbon fuels from crude oil.

Figure 1



0 2 . 1 Name the process represented by **Figure 1**.

[1 mark]

_____

0 2 . 2 Changes of state take place during the process in **Figure 1**.

Name the change of state taking place in:

- the heater
- the column.

[2 marks]

Heater _____

Column _____

4.3.1.1 Conservation of mass and balanced chemical equations

Question 70 · continued

Different fuels are obtained from crude oil at the points on **Figure 1** labelled **A** to **E**.

Table 2 shows the boiling point ranges of different fuels obtained from the process in **Figure 1**.

Table 2

Fuel	Boiling point range in °C
Diesel oil	260 – 320
Heavy fuel oil	320 – 400
Kerosene	180 – 260
Petrol	40 – 110
Petroleum gases	Below 30

0 2 . 3 Which fuel is obtained at **B** in the column?

Use **Figure 1** and **Table 2**.

[1 mark]

0 2 . 4 Fuels with higher boiling point ranges contain larger molecules.

What is the order of increasing flammability of the fuels?

Use **Table 2**.

[1 mark]

Tick (✓) **one** box.

Heavy fuel oil ⟶ diesel oil ⟶ kerosene ☐

Heavy fuel oil ⟶ kerosene ⟶ diesel oil ☐

Kerosene ⟶ diesel oil ⟶ heavy fuel oil ☐

Kerosene ⟶ heavy fuel oil ⟶ diesel oil ☐

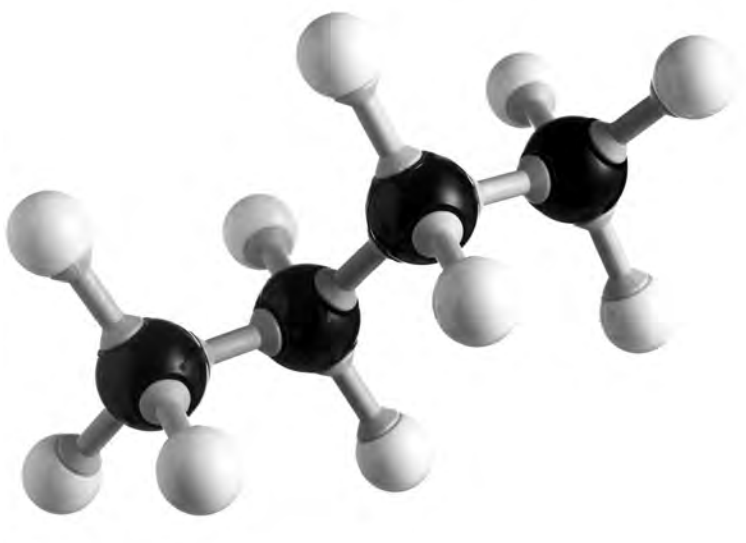
4.3.1.1 Conservation of mass and balanced chemical equations

Question 70 · continued

Liquified petroleum gases are a mixture of several different hydrocarbons.

Figure 2 shows a model of one of these hydrocarbons.

Figure 2



0 2 . 5 Write the molecular formula of the hydrocarbon represented by the model in **Figure 2**.

[1 mark]

0 2 . 6 Name the hydrocarbon represented by the model in **Figure 2**.

[1 mark]

0 2 . 7 Petroleum gases also contain a hydrocarbon with the formula C_3H_8

Balance the equation for the complete combustion of C_3H_8

[2 marks]

$$C_3H_8 + 5\ O_2 \rightarrow ___\ CO_2 + ___\ H_2O$$

9