AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.4.1.4

Oxidation and reduction in terms of electrons (HT only)

Past-paper questions

Tier	**Higher**
Question groups	**27**
Available paper years	**2007–2022**

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.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 01

November 2007 | CHY1A | Original Q3 | Legacy

QUESTION THREE

The table shows the emissions of sulfur dioxide, in the United Kingdom (UK), by different fuels in 1990 and in 2004.

	Emissions of sulfur dioxide by different fuels in thousands of tonnes		
Fuel type	**1990**	**2004**	**Percentage change between 1990 and 2004**
Coal	2707	578	–79
Other solid fuels	66	20	–70
Petroleum fuel oil	605	78	–87
Other petroleum products (including petrol and diesel)	193	83	–57
Gaseous fuels	9	11	+22
Other emissions of sulfur dioxide	118	58	–51
TOTAL	**3698**	**828**	**–78**

- Since 1990, the amount of coal used in the generation of electricity at power stations has reduced by more than 60%.
- Since 1990, gaseous fuels have gradually been replacing fuel oil for electricity generation and in industry.
- The small amount of sulfur dioxide emitted from petrol and diesel fuel used in vehicles has decreased. It should decrease further with the increased use of low-sulfur petrol and diesel.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 01 · continued

3A Which fuel had the largest reduction in sulfur dioxide emissions, **in thousands of tonnes**, between 1990 and 2004?

1 coal

2 fuel oil

3 other petroleum products

4 gaseous fuels

3B This data suggests that emissions of sulfur dioxide between 1990 and 2004 . . .

1 decreased for all fuels.

2 decreased by more than 50% for all fuels.

3 decreased by 78% for all fuels except gaseous fuels.

4 decreased by more than 50% for all fuels except gaseous fuels.

3C Which reasonable prediction can be made from the evidence given at the beginning of this question?

1 Sulfur dioxide emissions will begin to increase in the future as the number of vehicles on our roads increases.

2 Overall, sulfur dioxide emissions are likely to continue to decrease.

3 Supplies of fuel oil will be used up in another twenty years.

4 Sulfur dioxide emissions from gaseous fuels will be greater than those from coal in the near future.

3D The data in the table was obtained by estimating the sulfur dioxide emissions from power stations, industrial plants, vehicles, etc.

Sulfur dioxide emissions in the UK could also be monitored by . . .

1 providing each vehicle with a digital readout of sulfur dioxide emitted.

2 measuring the sulfur dioxide concentrations in the air above the largest power stations and industrial plants.

3 measuring the sulfur dioxide concentrations in the air at a large number of sites spread across the UK.

4 measuring the sulfur content of all fuels before they are used.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 02

November 2007 | CHY1A | Original Q7 | Legacy

QUESTION SEVEN

Aluminium (7.85%) and iron (4.12%) are the two most abundant metals in the Earth's crust.

Iron is extracted from iron oxide in a blast furnace.

The equations show two reactions that occur in the furnace.

$$FeO + C \rightarrow Fe + CO$$

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

7A Which substances are reduced and which substances cause the reduction in these two reactions?

	Substances reduced	Substances causing the reduction
1	iron	carbon and carbon monoxide
2	iron oxides	carbon monoxide and carbon dioxide
3	carbon and carbon dioxide	iron oxides
4	iron oxides	carbon and carbon monoxide

7B Aluminium **cannot** be extracted from its ores in a blast furnace because . . .

1 it is more reactive than iron.

2 too many stages are needed in the process.

3 too much energy is required.

4 it is more reactive than carbon.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 02 · continued

7C Which two of the following statements could explain why aluminium is preferred to iron for making cans for drinks?

W Aluminium has a lower density than iron.

X Aluminium is a better conductor than iron.

Y Aluminium corrodes less easily than iron.

Z Aluminium is not as strong as iron.

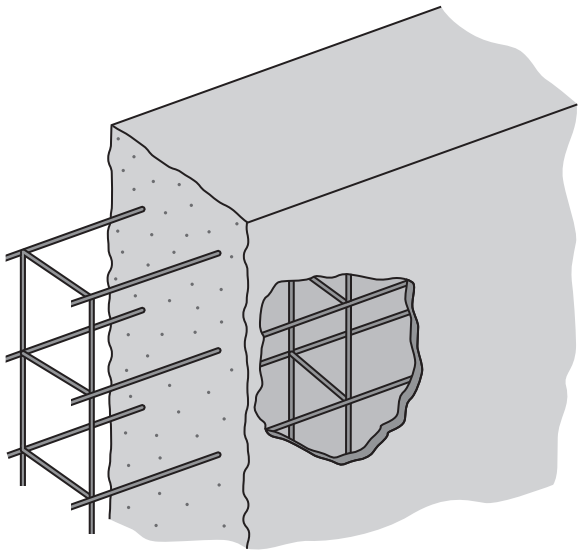
1 **W** and **X**

2 **W** and **Y**

3 **X** and **Y**

4 **Y** and **Z**

7D The diagram shows some reinforced concrete.



Which one of the following is the best material to use to reinforce concrete?

1 cast iron

2 low carbon steel

3 high carbon steel

4 stainless steel

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 03

November 2007 | CHY1A | Original Q9 | Legacy

QUESTION NINE

In the 1980s, environmentalist Paul Ehrlich predicted that there would be a massive worldwide shortage of various natural resources. At the same time, economist Julian Simon said that natural resources were effectively infinite.

In 1988, the known resources of tin were estimated to last for 18 years. In 2006, there is still not a serious shortage of tin.

9A Which of the following is **not** a reason why Ehrlich's prediction of massive shortages has been proved wrong?

1 Existing materials have been recycled.

2 Existing resources have been used more efficiently.

3 More material has been imported.

4 New sources have been discovered.

9B The Coca-Cola company is a commercial organisation. Coke cans are now made from 80% less aluminium than 40 years ago.

What is the most probable reason for this?

1 The company sells more Coca-Cola than 40 years ago.

2 The price of aluminium has decreased.

3 There is a serious shortage of aluminium.

4 Thinner cans cut costs and increase profits.

9C The availability of metals has not decreased as fast as predicted 20 years ago. One reason for this is a reduction in the use of some metals.

Which of the following has **not** contributed to a reduction in the overall use of metals?

1 Environmental concerns have caused more people to use energy saving lamps which has reduced the demand for tungsten.

2 To reduce costs, 'tin' cans are now coated with plastic instead of tin.

3 To reduce corrosion, aluminium has replaced iron in some of the body parts of cars.

4 New technology has resulted in the use of more fibre optic cables and a reduced use of copper wire.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 03 · continued

9D The main source of tin is the ore tin sulfide. This is used to make tin oxide. The tin oxide is then heated with carbon to obtain the metal.

Why does it normally take less energy to obtain tin from scrap tin than to extract the tin from its ore?

1 There are more impurities in scrap tin than in the tin ore.

2 More waste materials are left from scrap tin than from tin ore.

3 Scrap tin does not need to be reduced to tin.

4 Tin sulfide contains the element sulfur.

END OF TEST

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 04

6 Photographic film often contains silver bromide. Silver bromide is changed by light to form silver which appears as a black solid. This darkens the photographic film.

A photographic film can be made by coating thin transparent plastic with a gel containing silver bromide.

The main steps in making this photographic film are as follows:

Step 1 Gelatine is dissolved in warm water to make a solution.

Step 2 Compound **A**, a soluble compound which contains bromide ions, is dissolved into this solution.

Step 3 The lights are turned out in the darkroom.

Step 4 Compound **B**, a soluble compound which contains silver ions, is dissolved in water.

Step 5 The solution of compound **B** is added to the solution containing compound **A** and gelatine. Solid silver bromide is formed.

Step 6 The warm mixture is poured onto thin, transparent plastic film.

Step 7 The mixture sets to form a gel containing solid silver bromide.

(a) The table below gives information about the solubility of some compounds.

SOLUBLE	INSOLUBLE
All sodium and potassium salts	
All nitrates	
Most chlorides, bromides and iodides	Silver and lead chlorides, bromides and iodides
Most sulfates	Lead sulfate and barium sulfate
Sodium, potassium and ammonium carbonates	Most other carbonates

Use the table to help you to name suitable compounds for **A** and **B**.

Compound **A** .....

Compound **B** .....

(2 marks)

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 04 · continued

BLANK

(b) Suggest why the lights are turned out at **step 3** in this method of making a photographic film.

.....

.....

(1 mark)

(c) What type of chemical reaction takes place when the compounds are mixed in **step 5**?

.....

(1 mark)

(d) The photographic film is placed in a camera and a picture is taken. Where light hits the photographic film the silver ions (Ag^+) are changed into silver metal (Ag).

Explain why this reaction is a reduction.

.....

.....

.....

.....

(2 marks)

6

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 05

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

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

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

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 06

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

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 06 · continued

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

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

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

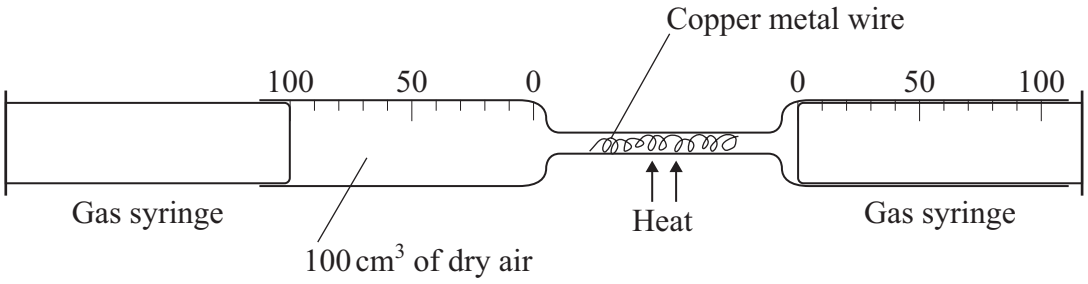
4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 07

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

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 07 · 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 $2Cu + 2O_2 \rightarrow 2CuO$

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 08

June 2009 | CHY1H | Original Q4 | Legacy

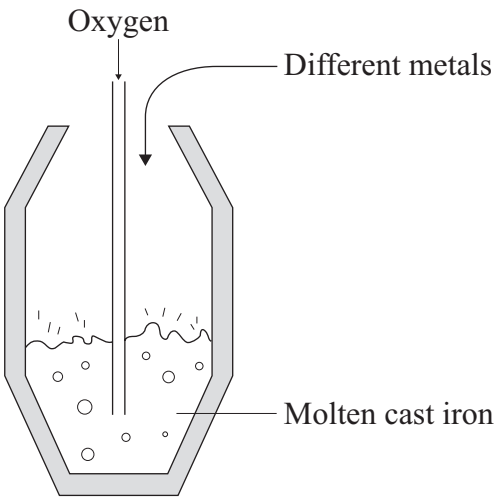
4 The demand for iron and steel is high.

4 (a) Iron that is extracted from its oxide by carbon reduction in a blast furnace is called cast iron. Cast iron contains about 4% carbon. This carbon makes cast iron very brittle.

Carbon steels can be made by the following processes.

- Blowing oxygen into molten cast iron to remove most of the carbon.
- Adding a calculated amount of carbon.

Sometimes different metals may also be added to the molten carbon steels.



4 (a) (i) Suggest how blowing oxygen into molten cast iron removes most of the carbon.

.....

.....

.....

.....

(2 marks)

4 (a) (ii) Why are different metals sometimes added to molten carbon steels?

.....

.....

(1 mark)

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 08 · continued

for mark

4 (b) The percentage of iron and steel recycled in the UK has been increasing.

Year	% iron and steel recycled
1998	25
2000	35
2002	42
2004	46
2006	57

The UK government has set targets for the percentage of iron and steel to be recycled. In 2006 the target was exceeded.

Suggest **two** reasons why the UK government wants to encourage recycling of iron and steel.

1 .....

.....

2 .....

.....

(2 marks)

5

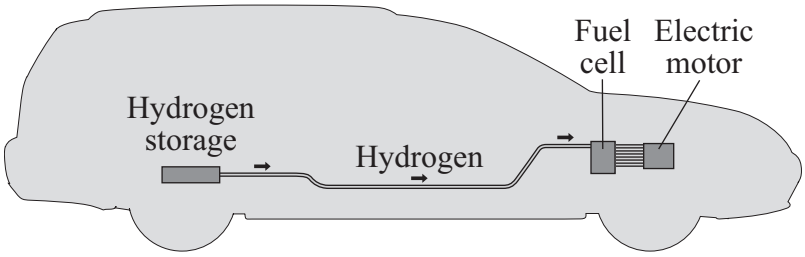
4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 09

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.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 09 · 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

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 09 · 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.

.....

.....

.....

.....

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(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)

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 09 · continued June 2009 | CHY2H | Original Q5 | Legacy

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.

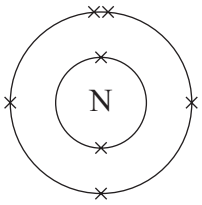
Explain why.

.....

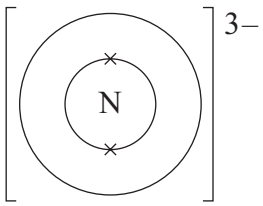
.....

(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

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 10

March 2010 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about types of reactions.

Match type of reaction, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A reduction

B combustion

C thermal decomposition

D corrosion

	Example of the type of reaction
1	Copper carbonate forms copper oxide and carbon dioxide when heated.
2	Hydrogen reacts with oxygen to produce water.
3	Carbon steels react when exposed to air and water.
4	Zinc is obtained from zinc oxide by removal of the oxygen.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 11

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

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 11 · 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.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 12

March 2010 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

All the gases in the Earth's atmosphere can be separated by this method:

- remove the carbon dioxide
- cool the air down to a very low temperature so that it liquefies
- allow the liquefied gases to warm up
- collect the gases as they boil off at different temperatures.

The table below gives some information about the gases in the Earth's atmosphere.

Gas	Melting point in °C	Boiling point in °C	Abundance in %
Oxygen	−223	−183	21
Nitrogen	−209	−196	78
Carbon dioxide	−57	−57	0.03
Helium	−272	−269	Less than 0.1
Neon	−248	−246	Less than 0.1
Argon	−189	−186	0.9
Krypton	−157	−153	Less than 0.1
Xenon	−112	−108	Less than 0.1

8A In this method of separation, carbon dioxide is always removed from the air before it is liquefied because . . .

1 it would react with the other gases present.

2 it would solidify during cooling and block up the pipes.

3 it is a greenhouse gas and would warm up the apparatus.

4 it is a heavy gas and would not separate properly from the mixture.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 12 · continued

8B How many of the gases listed in the table (excluding carbon dioxide), would be liquid at –150 °C?

1 None

2 1

3 2

4 3

8C Argon is the cheapest of the noble gases to produce because . . .

1 there is high demand for it for use in light bulbs.

2 it is the most abundant of the noble gases.

3 it is the gas that vaporises most easily and so requires the least energy to remove it.

4 it is an unreactive gas so it can easily be separated from the other gases in the air.

8D Earth's early atmosphere contained a high percentage (%) of carbon dioxide.

One reason for the reduction of the percentage of carbon dioxide is that carbon dioxide . . .

1 has dissolved in the oceans.

2 has been reduced to carbon monoxide.

3 has decomposed to form carbon and oxygen.

4 has been released by plants.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 13

June 2010 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about the substances in this reaction:

$$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$$

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

A C

B Fe

C CO

D Fe_2O_3

1	In the reaction, it is reduced.
2	It is a transition element.
3	In the reaction, it is oxidised.
4	It is formed by oxidation of a non-metal element.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 14

June 2010 | CHY1BP | Original Q9 | Legacy

QUESTION NINE

'Food miles' is the distance that food is transported from the time of its production until it reaches the consumer.

Environmentalists are concerned that food miles are increasing and that this is causing increased carbon dioxide emissions.

The table shows some of the social costs of transporting food to and within the UK in 2002.
At the time there were about 32 million vehicles on UK roads, 25 million of which were cars.

The values shown are an indication of the damage to the environment caused by the transport of food. The larger the number, the greater the environmental damage.

Type of transport	Carbon dioxide emissions	Reduction in air quality	Noise from transport	Congestion due to transport
Lorry	120	170	120	1400
Van	30	50	30	1100
Car	50	20	40	2600
Train	0	20	0	0

9A Which one of the following would explain the difference between the congestion values due to 'Vans' and 'Cars'?

1 A van will cover more distance than a car on a tank of fuel.

2 Cars will travel down more minor roads than vans.

3 Vans can carry larger loads than cars.

4 There are more cars than vans on UK roads.

9B The table shows that there is no damage caused by carbon dioxide emissions from trains. This is because the trains referred to in the table are electric trains.

This is misleading, mainly because . . .

1 it does not take into account the lighting used at railway stations.

2 the carbon dioxide emissions given off by railway staff travelling to work should also be included.

3 carbon dioxide is given off when electricity is generated using fossil fuels.

4 the environmental effect of driving goods to railway stations should be included.

Question 14 · continued

9C Haulage companies suggest that transporting goods by lorries is preferable to using vans.

If all environmental aspects are considered, how many vans cause as much environmental damage as one lorry?

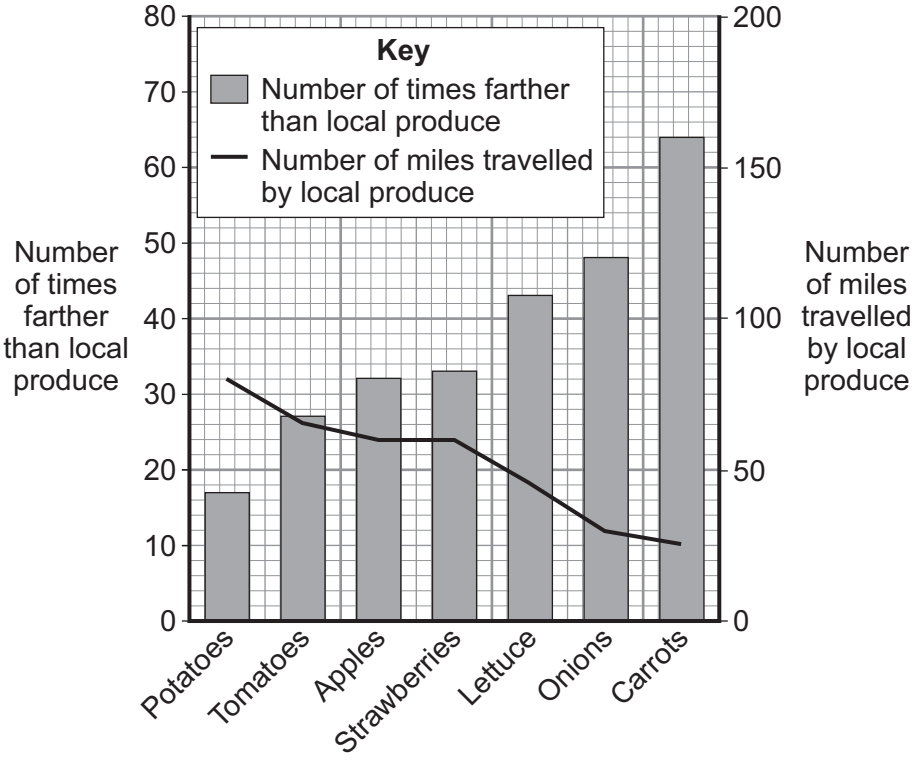
1 less than one

2 between one and two

3 between two and three

4 between three and four

9D The graph shows the relative distances travelled when transporting food to the UK from a distant source compared with locally produced food.



Which food from a distant source travels the least food miles compared with when it is produced locally?

1 potatoes

2 strawberries

3 lettuce

4 carrots

END OF TEST

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 15

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)

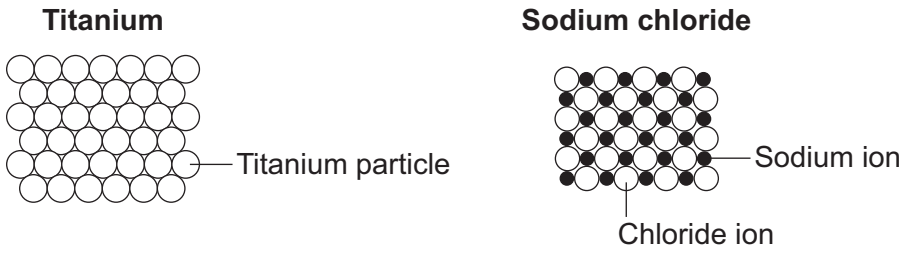
4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 15 · 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.



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

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 16

June 2011 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

Iron and copper can be extracted from their oxides by reduction with carbon.
Aluminium cannot be extracted from its oxide in this way.

Copper can be found in the Earth's crust as the metal itself.
Iron and aluminium are found only as compounds in the Earth's crust.

5A Which row in the table shows the order of reactivity of the four elements in the passage above?

	Most reactive →			Least reactive
1	copper	iron	aluminium	carbon
2	aluminium	carbon	iron	copper
3	carbon	copper	iron	aluminium
4	iron	aluminium	copper	carbon

5B Iron can be extracted from iron oxide, Fe_2O_3, by mixing the oxide with carbon and heating strongly in air.

Which row in the table below shows the name of the process and the products of the reaction?

	Name of the process	Products of the reaction
1	electrolysis	Fe, O_2 and CO_2
2	reduction	Fe and CO_2
3	electrolysis	Fe and CO_2
4	reduction	Fe, O_2 and CO_2

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 16 · continued June 2011 | CHY1AP | Original Q5 | Legacy

5C Copper is extracted from high grade ores by first heating them strongly in a furnace to obtain impure copper. This is called smelting. Pure copper is then obtained by electrolysis.

Copper is extracted from low grade ores by leaching. A solution of sulfuric acid is run through the ores to produce a solution of copper sulfate. Electrolysis of this solution gives pure copper.

An advantage of leaching over smelting is that . . .

1 leaching uses less energy.

2 leaching causes no environmental damage.

3 leaching leaves no waste.

4 leaching produces purer copper.

5D Extraction of aluminium from its ores requires a lot of energy. Aluminium obtained by recycling scrap aluminium saves about 95% of this energy.

Another advantage of recycling scrap aluminium is that . . .

1 large, new aluminium ore mines will be developed.

2 alternative metals will replace aluminium in making drinks cans.

3 deposits of aluminium ore will last longer.

4 recycled aluminium contains other metals.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 17

June 2011 | CHY1AP | Original Q9 | Legacy

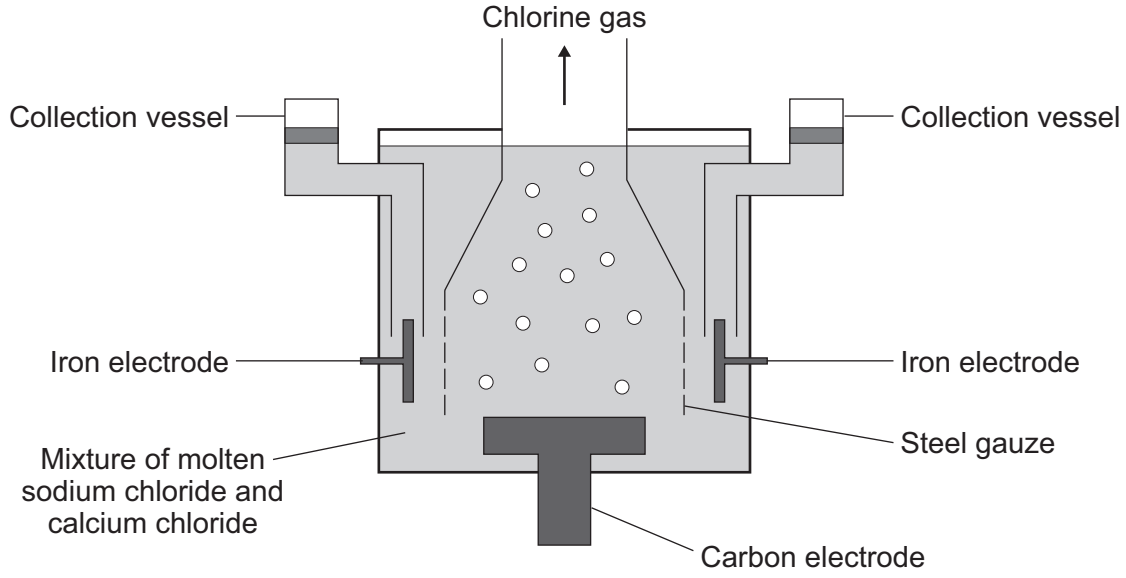
QUESTION NINE

Sodium cannot be extracted from its oxide by reduction with carbon.

Sodium metal is extracted by electrolysis of molten sodium chloride. The melting point of sodium chloride is very high (800°C), so calcium chloride is added to reduce the melting point of the mixture to about 550°C.

During electrolysis, both sodium and calcium are obtained at the iron electrodes, and chlorine at the carbon electrode.

The diagram shows the electrolysis cell used for the extraction of sodium.



The table shows some properties of sodium and calcium.

	Melting point in °C	Density in g per cm^3	Reactivity
Sodium	97	0.97	Very reactive
Calcium	839	1.55	Reactive

9A In the extraction of sodium, a mixture of sodium chloride and calcium chloride is used to . . .

1 reduce the amount of energy required to melt the mixture.

2 obtain a pure sample of sodium.

3 absorb the chlorine gas.

4 increase the temperature of the mixture.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 17 · continued

9B The purpose of the steel gauze is to prevent the reaction of . . .

1 sodium with calcium.

2 sodium with chlorine.

3 iron electrodes with sodium chloride.

4 sodium chloride with calcium chloride.

9C In the collection vessel there is . . .

1 solid sodium below a layer of liquid calcium.

2 solid calcium below a layer of liquid sodium.

3 a mixture of liquid sodium and liquid calcium.

4 a mixture of solid calcium and solid sodium.

9D The information in the diagram suggests that the element carbon . . .

1 has a melting point lower than 550 °C.

2 reacts rapidly with chlorine gas.

3 is an electrical conductor.

4 is more reactive than iron.

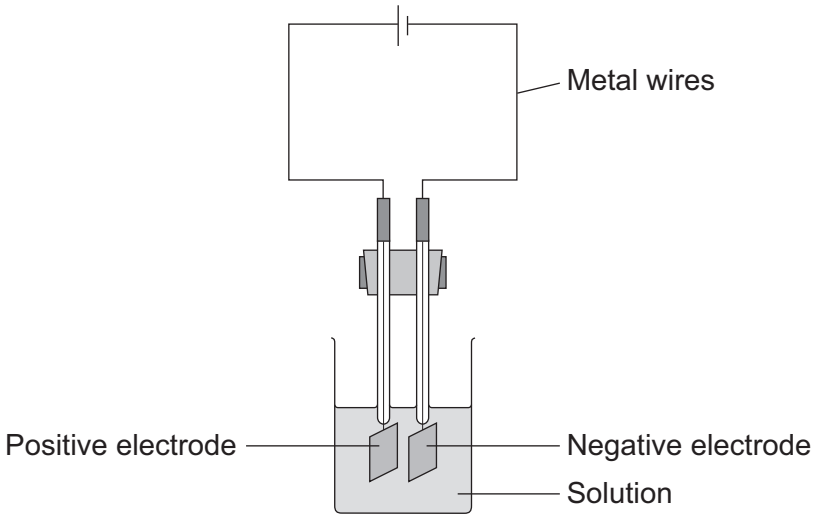
END OF TEST

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 18

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)

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 18 · 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

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 19

November 2011 | CHY1AP | Original Q4 | Legacy

QUESTION FOUR

Iron oxide can be reduced to iron by mixing the oxide with carbon and heating strongly.

Aluminium oxide cannot be reduced to aluminium in this way. Aluminium is obtained from aluminium oxide by electrolysis.

4A Why is it possible to obtain iron but not aluminium by carbon reduction?

1 Iron is more reactive than aluminium.

2 Carbon is more reactive than aluminium but less reactive than iron.

3 Carbon is more reactive than iron but less reactive than aluminium.

4 Aluminium and iron are both more reactive than carbon.

4B The extraction of aluminium by electrolysis is an expensive process because . . .

1 aluminium easily corrodes in air.

2 a large amount of energy is needed.

3 aluminium oxide is difficult to mine.

4 aluminium reacts with carbon.

4C As electrolysis is expensive, an increasing amount of aluminium is being recycled.

Another important reason to recycle aluminium is that . . .

1 it saves limited aluminium oxide reserves.

2 the recycled aluminium is purer.

3 aluminium scrap does not corrode easily.

4 recycling aluminium does not use energy.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 19 · continued

4D Which two of the following statements could explain why aluminium is preferred to iron for making cans for drinks?

W Aluminium has a lower density than iron.

X Aluminium is a better conductor than iron.

Y Aluminium corrodes less easily than iron.

Z Aluminium is not as strong as iron.

1 **W** and **X**

2 **W** and **Y**

3 **X** and **Y**

4 **Y** and **Z**

Turn over for the next question

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 20

November 2011 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

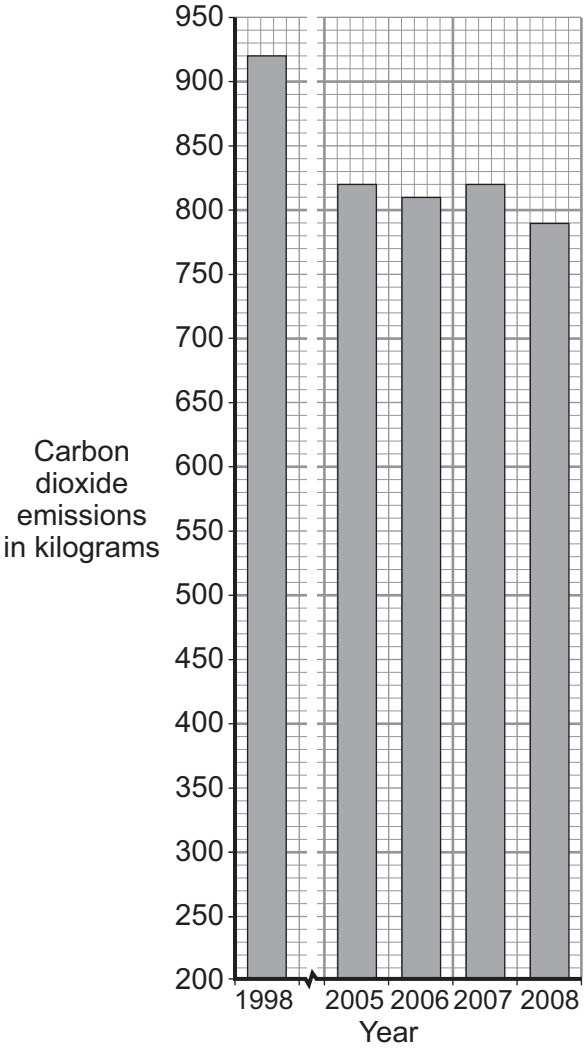
Cement is made in a rotary kiln, from a mixture of limestone and clay. The kiln is heated by burning a hydrocarbon fuel in air.

The cement industry needs to reduce carbon dioxide emissions.

Graphs 1 and **2** show carbon dioxide emissions from cement manufacture in Britain, between 1998 and 2008.

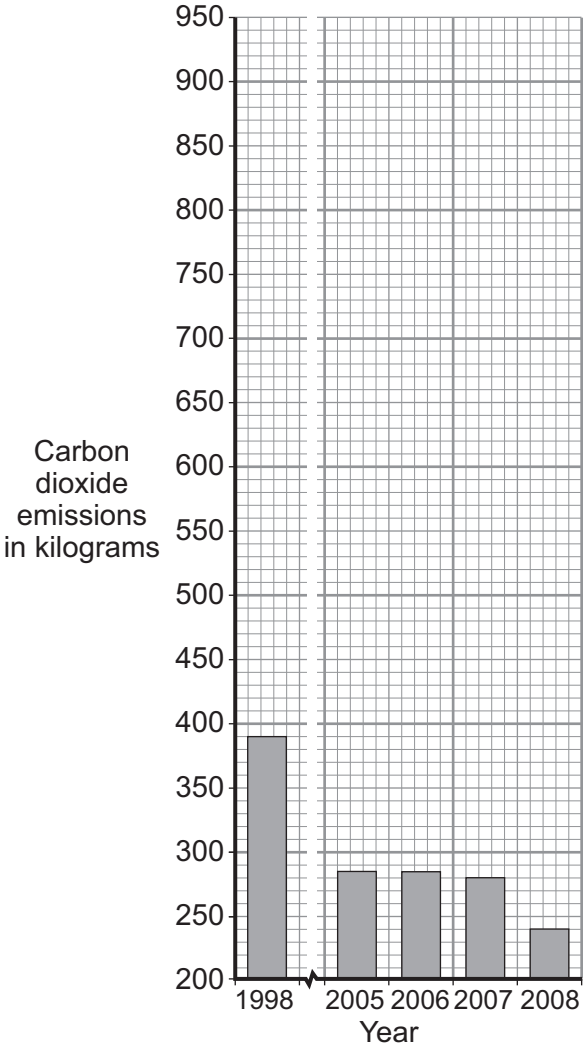
Graph 1

Total carbon dioxide emissions from factories per tonne of cement manufactured



Graph 2

Carbon dioxide emissions from combustion of hydrocarbon fuels per tonne of cement manufactured



4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

5A A correct conclusion from the information in the graphs is that . . .

1 the largest reduction in total emissions of carbon dioxide was from 1998 to 1999.

2 the largest reduction in emissions of carbon dioxide from combustion of hydrocarbon fuels was from 2007 to 2008.

3 from 2007 to 2008, total emissions of carbon dioxide, per tonne of cement manufactured, reduced by 40 kilograms.

4 from 2007 to 2008, emissions of carbon dioxide from combustion of hydrocarbon fuels, per tonne of cement manufactured, reduced by 40 kilograms.

5B What was the percentage reduction in emissions of carbon dioxide from combustion of hydrocarbon fuels at cement factories between 1998 and 2008?

1 16.2 %

2 38.5 %

3 61.5 %

4 84.4 %

5C What proportion of the carbon dioxide released during cement manufacture in 2006 came from combustion of hydrocarbon fuels?

1 0.23

2 0.35

3 0.61

4 0.85

5D Most of the carbon dioxide released during cement manufacture comes from . . .

1 hydrocarbons.

2 limestone.

3 quicklime.

4 slaked lime.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 21

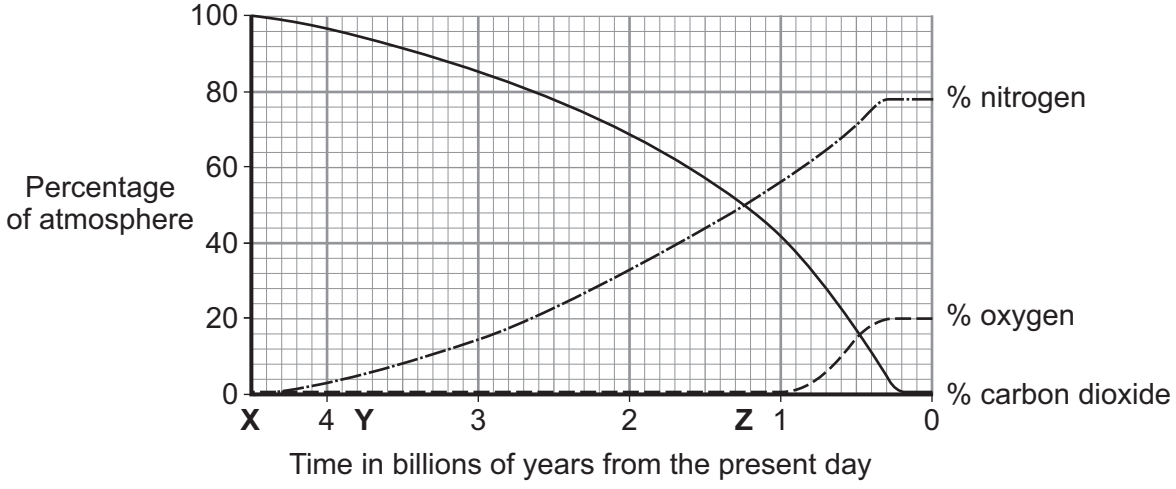
November 2011 | CHY1BP | Original Q7 | Legacy

QUESTION SEVEN

This question is about changes in the Earth's atmosphere that have occurred over time.

The Earth's early atmosphere was mainly carbon dioxide with small amounts of methane and ammonia.

The graph shows how the percentages of carbon dioxide, nitrogen and oxygen may have changed over time.



7A About how many years after the Earth was formed (**X**) did the percentage of carbon dioxide in the atmosphere fall to 60 %?

1 1.3 billion years

2 1.6 billion years

3 2.4 billion years

4 2.9 billion years

7B At a particular stage in the Earth's formation, some of the iron on its surface was oxidised.

What gas in the atmosphere could **not** have caused this change?

1 nitrogen

2 carbon dioxide

3 oxygen

4 water vapour

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 21 · continued

7C Between times **Y** and **Z**, the amount of carbon dioxide in the atmosphere was reduced.

Which of the following statements could explain this reduction?

Most of the carbon dioxide . . .

1 dissolved in the oceans.

2 was absorbed by plants.

3 was absorbed to form carbonate rocks in the mantle.

4 became locked up in coal, oil and natural gas.

7D The graph showing the percentages of the various gases has . . .

1 categoric variables plotted against a discrete variable.

2 discrete variables plotted against a continuous variable.

3 continuous variables plotted against a continuous variable.

4 continuous variables plotted against a discrete variable.

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 22

June 2014 | CH1HP | Original Q1 | Legacy

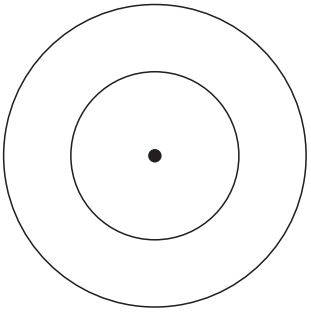
1 Fossil fuels contain carbon and hydrogen.

1 (a) (i) Use the Chemistry Data Sheet to help you to answer this question.

Complete **Figure 1** to show the electronic structure of a carbon atom.

[1 mark]

Figure 1



1 (a) (ii) Complete the word equation for the oxidation of hydrogen.

[1 mark]

hydrogen + oxygen ⟶ .....

1 (b) Coal is a fossil fuel.

Coal contains the elements hydrogen, sulfur, oxygen and carbon.

Name **two** products of burning coal that have an impact on the environment.

What impact does each of the products you named have on the environment?

[4 marks]

.....

.....

.....

.....

.....

.....

.....

.....

6

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

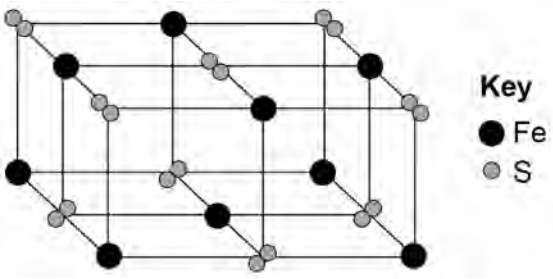
Question 23

0 2 This question is about metals and metal compounds.

0 2 . 1 Iron pyrites is an ionic compound.

Figure 1 shows a structure for iron pyrites.

Figure 1



Determine the formula of iron pyrites.

Use **Figure 1**.

[1 mark]

_____

0 2 . 2 An atom of iron is represented as $^{56}_{26}Fe$

Give the number of protons, neutrons and electrons in this atom of iron.

[3 marks]

Number of protons _____

Number of neutrons _____

Number of electrons _____

0 2 . 3 Iron is a transition metal.

Sodium is a Group 1 metal.

Give **two** differences between the properties of iron and sodium.

[2 marks]

1 _____

_____

2 _____

_____

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 23 · continued

Nickel is extracted from nickel oxide by reduction with carbon.

0 2 . 4 Explain why carbon can be used to extract nickel from nickel oxide.

[2 marks]

0 2 . 5 An equation for the reaction is:

$$NiO + C \rightarrow Ni + CO$$

Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses (A_r): C = 12 Ni = 59

Relative formula mass (M_r): NiO = 75

Give your answer to 3 significant figures.

[3 marks]

Percentage atom economy = _____ %

11

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 24

June 2018 | 8462/1H | Original Q8

0 8 Titanium is a transition metal.

Titanium is extracted from titanium dioxide in a two stage industrial process.

Stage 1 $TiO_2 + 2\,C + 2\,Cl_2 \rightarrow TiCl_4 + 2\,CO$

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

0 8 . 1 Suggest **one** hazard associated with **Stage 1**.

[1 mark]

0 8 . 2 Water must be kept away from the reaction in **Stage 2**.

Give **one** reason why it would be hazardous if water came into contact with sodium.

[1 mark]

0 8 . 3 Suggest why the reaction in **Stage 2** is carried out in an atmosphere of argon and **not** in air.

[2 marks]

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 24 · continued

0 8 . 4 Titanium chloride is a liquid at room temperature.

Explain why you would **not** expect titanium chloride to be a liquid at room temperature.

[3 marks]

In **Stage 2**, sodium displaces titanium from titanium chloride.

0 8 . 5 Sodium atoms are oxidised to sodium ions in this reaction.

Why is this an oxidation reaction?

[1 mark]

0 8 . 6 Complete the half equation for the oxidation reaction.

[1 mark]

Na → _____ + _____

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 24 · continued

0 8 . 7 In **Stage 2**, 40 kg of titanium chloride was added to 20 kg of sodium.

The equation for the reaction is:

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

Relative atomic masses (A_r): Na = 23 Cl = 35.5 Ti = 48

Explain why titanium chloride is the limiting reactant.

You **must** show your working.

[4 marks]

0 8 . 8 For a **Stage 2** reaction the percentage yield was 92.3%

The theoretical maximum mass of titanium produced in this batch was 13.5 kg.

Calculate the actual mass of titanium produced.

[2 marks]

Mass of titanium = _____ kg

15

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 25

November 2020 | 8462/1H | Original Q6

0 6 This question is about displacement reactions.

0 6 . 1 The displacement reaction between aluminium and iron oxide has a high activation energy.

What is meant by 'activation energy'?

[1 mark]

0 6 . 2 A mixture contains 1.00 kg of aluminium and 3.00 kg of iron oxide.

The equation for the reaction is:

$$2\,Al + Fe_2O_3 \rightarrow 2\,Fe + Al_2O_3$$

Show that aluminium is the limiting reactant.

Relative atomic masses (A_r): O = 16 Al = 27 Fe = 56

[4 marks]

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 25 · continued

November 2020 | 8462/1H | Original Q6

Magnesium displaces zinc from zinc sulfate solution.

0 6 . 3 Complete the ionic equation for the reaction.

You should include state symbols.

[2 marks]

$$Mg(s) + Zn^{2+}(aq) \rightarrow _____ + _____$$

0 6 . 4 Explain why the reaction between magnesium atoms and zinc ions is both oxidation and reduction.

[2 marks]

9

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 26

November 2021 | 8462/1H | Original Q3

0 3 This question is about the extraction of metals.

Element **R** is extracted from its oxide by reduction with hydrogen.

The equation for the reaction is:

$$3\,H_2 + \mathbf{R}O_3 \rightarrow \mathbf{R} + 3\,H_2O$$

0 3 . 1 The sum of the relative formula masses (M_r) of the reactants ($3\,H_2$ + $\mathbf{R}O_3$) is 150

Calculate the relative atomic mass (A_r) of **R**.

Relative atomic masses (A_r): H = 1 O = 16

[2 marks]

Relative atomic mass (A_r) of **R** = _____

0 3 . 2 Identify element **R**.

You should use:

- your answer to **question 03.1**
- the periodic table.

[1 mark]

Identity of **R** = _____

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 26 · continued

0 3 . 3 Carbon is used to extract tin (Sn) from tin oxide (SnO_2).

The equation for the reaction is:

$$SnO_2 + C \rightarrow Sn + CO_2$$

Calculate the percentage atom economy for extracting tin in this reaction.

Relative atomic masses (A_r): C = 12 O = 16 Sn = 119

[3 marks]

Percentage atom economy = _____ %

Question 3 continues on the next page

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 26 · continued

0 3 . 4 Tungsten (W) is a metal.

Tungsten is extracted from tungsten oxide (WO_3).

All other solid products from the extraction method must be separated from the tungsten.

Table 2 shows information about three possible methods to extract tungsten from tungsten oxide.

Table 2

Method	Reactant	Relative cost of reactant	Products
1	Carbon	Low	Tungsten solid Carbon dioxide gas Tungsten carbide solid
2	Hydrogen	High	Tungsten solid Water vapour
3	Iron	Low	Tungsten solid Iron oxide solid

Evaluate the three possible methods for extracting tungsten from tungsten oxide.

[4 marks]

10

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 27

June 2022 | 8462/1H | Original Q4

0 4 This question is about zinc and compounds of zinc.

A student produces pure crystals of zinc chloride by reacting zinc oxide with hydrochloric acid.

The equation for the reaction is:

$$ZnO(s) + 2\,HCl(aq) \rightarrow ZnCl_2(aq) + H_2O(l)$$

0 4 . 1 The student adds zinc oxide to hydrochloric acid until the zinc oxide is in excess.

Give **one** observation that the student could make to show that the zinc oxide is in excess.

[1 mark]

0 4 . 2 Why is excess zinc oxide used rather than excess hydrochloric acid?

[1 mark]

0 4 . 3 Name **one other** compound that the student could add to hydrochloric acid to produce zinc chloride.

[1 mark]

0 4 . 4 Describe how the student should obtain crystals of zinc chloride from a solution of zinc chloride.

[2 marks]

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

Question 27 · continued

Zinc chloride is also produced in a displacement reaction between zinc and copper chloride solution.

The equation for the reaction is:

$$Zn + CuCl_2 \rightarrow ZnCl_2 + Cu$$

0 4 . 5 Complete the ionic equation for this reaction.

[1 mark]

$$Zn + \underline{\qquad\qquad} \rightarrow Zn^{2+} + \underline{\qquad\qquad}$$

0 4 . 6 Why is zinc described as being oxidised in this reaction?

[1 mark]

4.4.1.4 Oxidation and reduction in terms of electrons (HT only)

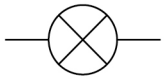
Question 27 · continued

0 4 . 7 Zinc and copper can be used with another substance to produce electricity.

Complete **Figure 7** to show how zinc, copper and another substance can be used to light a lamp.

Label:

- zinc
- copper
- the other substance used.

The symbol  represents the lamp.

[3 marks]

Figure 7

