GCSE

Rewarding Learning

CCEA GCSE

Exemplifying Examination Performance

Double Award Science Chemistry

Higher Tier

Grade A

This is an exemplification of candidates' performance in GCSE examinations (Summer 2019) to support the teaching and learning of the Double Award Science specification.

EXEMPLIFYING EXAMINATION PERFORMANCE

GCSE Double Award Science

Introduction

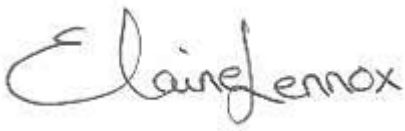
These materials illustrate aspects of performance from the 2019 summer GCSE examination series of CCEA's revised GCSE Specification in 2017.

Students' grade A responses are reproduced verbatim and accompanied by commentaries written by senior examiners. The commentaries draw attention to the strengths of the students' responses and indicate, where appropriate, deficiencies and how improvements could be made.

It is intended that the materials should provide a benchmark of candidate performance and help teachers and students to raise standards.

For further details of our support package, please visit our website at www.ccea.org.uk

Best wishes



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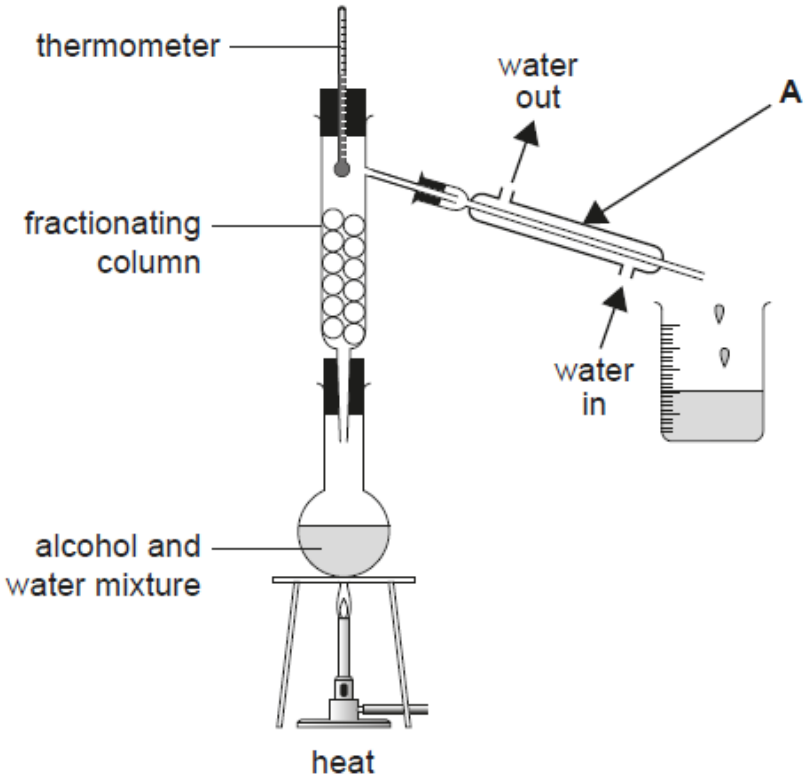
GCSE: Double Award Science

Chemistry Unit C1: Higher Tier

Grade: A Exemplar

Q1 The diagram below shows the apparatus that can be used in the laboratory to obtain a **pure** sample of **ethanol** from a mixture of ethanol and water.



Q1a(i) What is the **full** name of this separation process? [1]

Student's response

Fractional distillation.

Examiner's comments

The candidate was credited the mark for their correct response.

[1 mark awarded]

Q1a(ii) What is the name of the piece of apparatus labelled **A**? [1]

Student's response

Condensor

Examiner's comments

The candidate gained the mark for naming the correct piece of apparatus even with an incorrect spelling.

[1 mark awarded]

Q1a(iii) Why is water flowing through **A**? [1]

Student's response

Water flows through A to condense the gas back into a liquid to be collected.

Examiner's comments

The candidate was not awarded the mark as they didn't expand on the idea of a cold surface.

[0 marks awarded]

Q1b(i) Why can the sample of ethanol obtained from this process be described as pure? [1]

Student's response

It will not contain any water

Examiner's comments

Mark awarded for idea of a single substance or not mixed with anything else.

[1 mark awarded]

Q1b(ii) Which piece of apparatus in the diagram can be used to prove that the sample of ethanol collected is pure? [1]

Student's response

thermometer

Examiner's comments

This part of the question proved challenging for even some grade A candidates.

Candidates had to realise that the thermometer gave a specific reading indicating whether or not the substance was pure.

[1 mark awarded]

Q2a(i) The table below gives information about atomic structures. [4]

Complete the table by filling in the blank spaces.

Student's response

atom	atomic number	mass number	electronic configuration
A	6	12	2,4
B	*7*	14	2,5
C	6	14	*2,4*
D	14	28	*2,8,4*
E	*12*	24	2,8,2

Examiner's comments

This question was well answered by most grade A candidates. It required the ability to analyse data on atomic structure and complete the table.

[4 marks awarded]

Q2a(ii) Which two atoms **A**, **B**, **C**, **D** or **E** are isotopes? [1]

Student's response

B and *C*

Examiner's comments

This part of the question proved more challenging. It required the candidate to be able to spot the two isotopes which had the same atomic numbers but different mass numbers.

[0 marks awarded]

Q2b(i) Silicon has three naturally occurring isotopes.

Use the information in the table below to calculate the relative atomic mass of silicon to **two decimal places**. [2]

Show your working out.

Mass number	Relative abundance
28	93%
29	5%
30	2%

Student's response

mass x abundance /100

26·04

1·45

0·6

Σma = 28·09

(m x abun) + (m x abun) + (m x abun) = RAM

28.09 [2]

Examiner's comments

Full marks were awarded for this part of the question by most grade A candidates. Calculation of relative atomic masses from relative abundance data was well done.

[2 marks awarded]

Q3 Nanoparticles are used in healthcare, sports equipment, clothing and in sun creams.

Q3a What is the size of nanoparticles? Circle the correct answer. [1]

Student's response

0 – 1 nm 1 – 10 nm 10 – 100 nm (1 – 100 nm)

Examiner's comments

Correct answer for the size of nanoparticles as given in the specification as 1-100 was given.

[1 mark awarded]

Q3b The table below gives some uses of nanoparticles and the properties they provide to the products.

Property / Use	strong	better UV protection	light	antibacterial/ removes odours	transparent
golf clubs	✓		✓		
socks				✓	
sun creams		✓			✓

The nanoparticles in socks are made of silver while those in sun creams are made of zinc oxide and titanium dioxide.

Zinc oxide is a white material that gives good protection from UV rays.

Titanium dioxide is used to reduce the white colour and make sun creams less visible.

Use the information given to answer the following questions.

Q3b(i) Give the name of a transition metal mentioned in the passage. [1]

Student's response

titanium

Examiner's comments

Grade A candidates had no difficulty in correctly naming a transition metal.

[1 mark awarded]

Q3b(ii) Which nanoparticle is used to reduce the smell of sweaty feet? [1]

Student's response

Silver

Examiner's comments

Correct answer of silver was given.

[1 mark awarded]

Q3b(iii) What are the advantages of using nanomaterials in golf clubs? [1]

Student's response

Strong and *light*

Examiner's comments

Grade A candidates had no difficulty in correctly choosing strong and light as the correct answers. Both advantages were necessary to gain the mark.

[1 mark awarded]

Q3b(iv) Which chemical compound gives good protection from UV light? [1]

Student's response

Zinc oxide

Examiner's comments

Correct answer of zinc oxide was given.

[1 mark awarded]

Q3b(v) Which chemical substance makes the sun creams more transparent? [1]

Student's response

Titanium dioxide

Examiner's comments

The correct answer of titanium dioxide was given by most grade A candidates.

[1 mark awarded]

Q3c Give **one** risk other than 'harmful effect on the environment', associated with the use of nanoparticles in sun cream. [1]

Student's response

We do not know enough about them, no one unaware of any other damage they pose to us.

Examiner's comments

This answer required the knowledge that nanoparticles may cause harm to cells in the body. This is specifically mentioned 1.4.2 of the specification. To gain any credit cells had to be mentioned.

[0 marks awarded]

Q4 Magnesium fluoride is an ionic compound.

Q4a(i) What is the chemical formula of magnesium fluoride? [1]

Student's response

MgF_2

Examiner's comments

Most grade A candidates were able to give the correct chemical formula for magnesium fluoride.

[1 mark awarded]

Q4a(ii) Explain fully what happens to the electronic configuration **of the magnesium atom** when it forms an ionic bond with fluorine atoms. [2]

Student's response

The configuration goes from 2,8,2 to 2,8, as the atom has transferred 2 electrons to fluorine.

Examiner's comments

In this question the candidates were asked to give the changes to the electronic configuration of magnesium when it bonds with fluorine. Most grade A candidates were able to do this. One mark was for the loss of 2 electrons and the other mark was for giving the new electronic configuration of 2,8.

[2 marks awarded]

Q4a(iii) Explain what happens to the electronic configuration **of the fluorine atom** when it becomes a fluoride ion. [2]

Student's response

The fluorine atom's configuration goes from 2,7 to 2,8 as it has gained as electron, becoming an ion.

Examiner's comments

This answer required the changes to the electronic configuration of fluorine. One mark was for the gain of 1 electron and the second mark was for the new electronic configuration of 2,8.

[2 marks awarded]

Q4b(i) In each of the tables below there are three statements, **one** of which is correct.

Put a tick (✓) beside the correct statement in each table. [1]

Student's response

table 1	Tick (✓)
ionic bonds are typical of metal compounds	
ionic bonds are typical of metals	✓
ionic bonds are typical of non-metal compounds	

Examiner's comments

The specification 1.2.5 clearly states that ionic bonds are typical of metal compounds. This is not well known even by grade A candidates.

[0 marks awarded]

Q4b(ii) Put a tick (✓) beside the correct statement in each table. [1]

Student's response

table 2	Tick (✓)
most ionic compounds are insoluble in water	
many molecular covalent substances are insoluble in water	✓
most molecular covalent substances have high melting points	

Examiner's comments

The specification 1.3.5 states that many molecular covalent substances are insoluble in water. This was also poorly answered by some grade A candidates.

[1 mark awarded]

Q4b(iii) Put a tick (✓) beside the correct statement in each table. [1]

Student's response

table 3	Tick (✓)
diatomic means two atoms ionically bonded in a compound	
diatomic means two or more atoms chemically combined	
diatomic means two atoms covalently bonded in a molecule	✓

Examiner's comments

In the specification 1.2.10 the term diatomic is clearly given as meaning two atoms covalently bonded in a molecule. This is often poorly answered even by grade A candidates.

[1 mark awarded]

Q4c In the spaces below draw dot and cross diagrams to show how covalent bonding occurs in ammonia, NH_3.

Your diagrams should show:

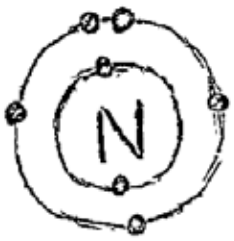
- the electronic structures of both of the atoms – show **all** electrons
- the electronic arrangement in an ammonia molecule – only outer electrons are needed
- a label showing a **lone pair** of electrons in the ammonia molecule.

[2] and [3]

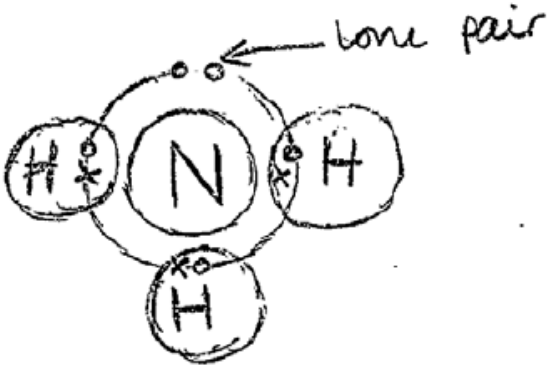
Student's response

hydrogen atom

nitrogen atom



ammonia molecule



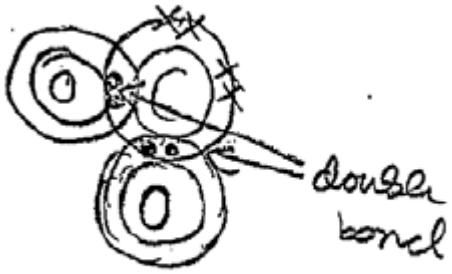
Examiner's comments

The correct diagrams for hydrogen, nitrogen and ammonia have all been given. The candidate has also labelled the lone pair of electrons correctly and used the dot cross correctly.

[5 marks awarded]

Q4d Draw a dot and cross diagram to show how covalent bonding occurs in carbon dioxide and label any multiple bonds. Only the outer electrons need to be shown. [3]

Student's response



Examiner's comments

The specification 1.2.8 requires candidates to be able to recall and draw dot cross diagrams for carbon dioxide showing the multiple bonds in the molecule. The marks were lost for incorrect sharing, incorrect total number of electrons and inability to label the multiple bonds.

[0 marks awarded]

Q5a This question is about relative formula masses, moles and percentage of an element by mass in a compound.

Calculate the relative formula mass of the following compounds:

(relative atomic masses: H = 1, N = 14, C = 12, O = 16, S = 32)

Q5a(i) sulfuric acid H_2SO_4 [1]

Student's response

2 + 32 + 64 = 98

98

Examiner's comments

Correct relative formula mass of 98 was given.

[1 mark awarded]

Q5a(ii) ammonium carbonate $(NH_4)_2CO_3$ [1]

Student's response

28 + 8 + 12 + 48 = 96

96

Examiner's comments

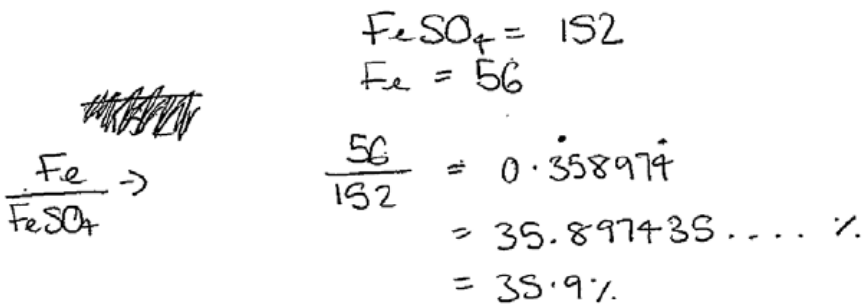
Most grade A candidates gained full marks for the relative formula mass of ammonium carbonate.

[1 mark awarded]

Q5b Iron(ll) sulfate, $FeSO_4$, (relative formula mass 152) is an essential body mineral. It helps keep our red blood cells healthy.

Calculate, to one decimal place, the percentage by mass of iron in iron(ll) sulfate. [3]

Student's response



35.9 %

Examiner's comments

The candidate correctly identified the numbers needed of 56 and 152. The mark was lost by a computation error giving 35.9 instead of 36.8. the candidate had correctly rounded up the answer to one decimal place and as a result only lost one mark.

[2 marks awarded]

Q5c The relative formula mass of glucose $C_6H_{12}O_6$ is 180.

Q5c(i) Calculate the number of moles in 45 g of glucose. [1]

Student's response

$$\text{moles} = \frac{\text{mass}}{\text{RFM}}$$

$$\text{moles} = \frac{45}{180}$$

$$= \frac{1}{4}$$

$$= 0.25$$

0.25

Examiner's comments

Generally well answered by grade A candidates.

[1 mark awarded]

Q5c(ii) What is the percentage composition of carbon, by mass, in a glucose molecule? [1]

Circle the correct answer.

Student's response

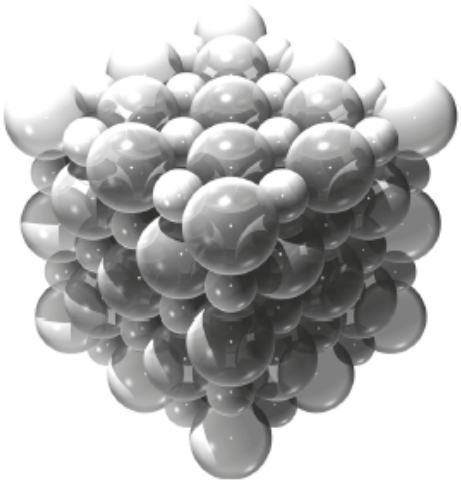
6% **15%** **25%** **33%** **40%** **50%**

Examiner's comments

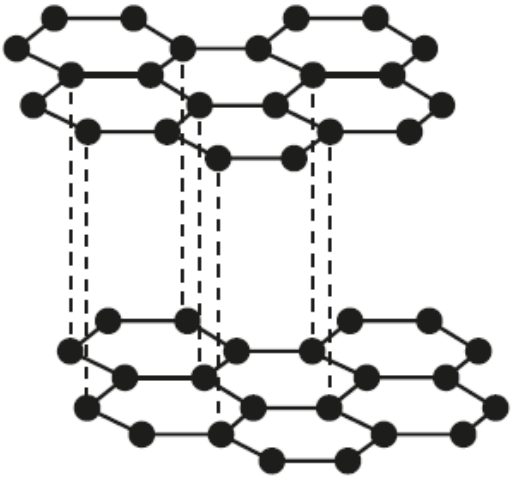
Grade A candidates had no difficulty in choosing the correct answer of 40%.

[1 mark awarded]

Q6 The diagrams below show two giant structures.



structure A



structure B

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

For **each** of these structures A and B:

- predict the physical properties you would expect them to have with respect to melting points, solubility in water and electrical conductivity.
- name the type of bonding you would expect.
- name a substance which could be represented by the structure
  and
  for structure B **only** give a use for a substance with that structure.

Structure A
Structure B [6]

Student's response

Structure A

Structure A represents an ionic compound, and ? would be expected to have high melting and boiling points. Furthermore, it would be expected to be soluble (able to dissolve in water) and would not conduct electricity, due to having no ? electrons. An example of ionic bonding is salt, also known as NaCl, or sodium chloride.

Structure B

Structure B represents giant covalent bonding. It is expected to conduct electricity, as a result of having 1 ? electron. It would be expected to have a high melting point, due to the many bonds visible, and would not dissolve in water. An example of giant covalent bonding as shown in graphite, and uses for it includes pencils , dry lubricant.

Examiner's comments

This was a QWC question with banded answers. In order to score in the top band the candidate had to gain at least two points for each of the structures given. Many candidates lost marks by wrongly interpreting structure A as diamond. They were still able to gain an indicative point for high melting point but their maximum score was limited to 4 as part of the middle band. Many grade A candidates were able to gain full marks by interpreting the structure A correctly as ionic. Structure B was much easier for candidates to recognize and so indicative points were scored readily for graphite although there was still some confusion with graphene.

[6 marks awarded]

Q7a The symbol equations below describe some reactions of dilute acids used in the laboratory.

$$HNO_3 + \textbf{alkali A} \longrightarrow KNO_3 + H_2O$$

$$H_2SO_4 + \textbf{base B} \longrightarrow CuSO_4 + H_2O$$

Give the **names** and **formulae** for:

alkali A [2]

base B [2]

Student's response

alkali A: name *potassium hydroxide* formula *KOH*

base B: name *_copper oxide* formula *CuO*

Examiner's comments

This was generally well answered by grade A candidates. Some however gave the names of the metals potassium and copper instead of the appropriate alkalis.

[4 marks awarded]

Q7b What is the difference between an alkali and a base? [1]

Student's response

an alkali forms hydroxides, bases form oxides

Examiner's comments

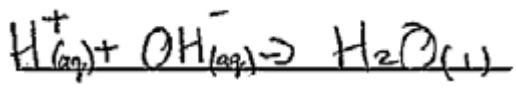
This question proved to be challenging for all candidates including some at grade A. The specification1.8.11 clearly states that an alkali is a soluble base.

[0 marks awarded]

Q7c Both of the reactions in part (a) involve neutralisation.

Write an ionic equation, including state symbols, for a neutralisation reaction. [3]

Student's response



Examiner's comments

Generally this question was well answered by most grade A candidates. Marks were lost if the state symbols were not in brackets.

[3 marks awarded]

Q7d(i) Nitric acid is described as a **strong** acid.

Complete the equation to show the ions formed when nitric acid is dissolved in water. [1]

Student's response

$HNO_3 \longrightarrow H^+ + NO_3$

Examiner's comments

The specification 1.8.6 requires candidates to be able to recall that strong acids including nitric acid are completely ionized in water. It was disappointing to see how this was so poorly answered even by grade A candidates. They were unable to give the two ions involved.

[0 marks awarded]

Q7d(ii) How would you describe the extent to which a strong acid is ionised in water?

Circle the correct answer [1]

Student's response

About 50% **100%** **1%** **a random %**

Examiner's comments

Most grade A candidates were able to score the mark for knowing that the acid would be completely dissociated into ions in water.

[1 mark awarded]

Q7d(iii) The symbol equation below shows the reaction of nitric acid with zinc metal.

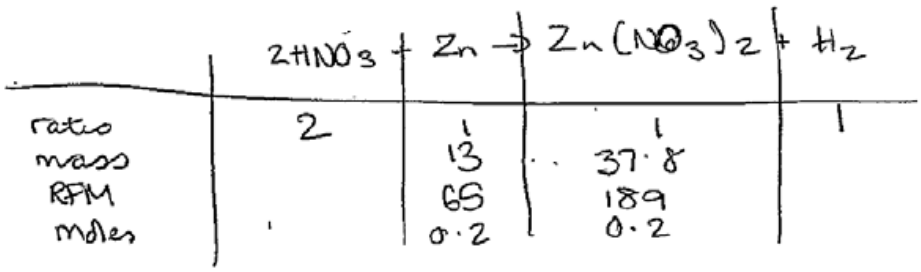
$$2HNO_3 + Zn \longrightarrow Zn(NO_3)_2 + H_2$$

(Relative atomic masses H = 1, N = 14, O = 16, Zn = 65)

Calculate the number of grams of zinc that would be needed to produce 37.8 g of zinc nitrate. [3]

Show your working.

Student's response



13g

Examiner's comments

In general grade A candidates were able to gain full marks for this calculation. The first mark was awarded for the correct relative formula of zinc nitrate. The second mark was for correctly dividing 37.8 by 189.

[3 marks awarded]

Q8 The table below gives some information about the noble gases.

noble gas	symbol	relative atomic mass	boiling point/ °C
helium	He	4	–269
neon	Ne	20	–246
argon	Ar	40	–186
krypton	Kr	84	–153
xenon	Xe	131	–108
radon	Rn	222	22 - 68

Q8a What is the trend in boiling points for the noble gases? [2]

Student's response

boiling point decreases as we go down the table.

Examiner's comments

Generally well answered by grade A candidates. Mark was lost here for not realizing that the boiling points which were negative numbers were increasing as you move down the group.

[1 mark awarded]

Q8b Why does the number of electrons in the outer shell of each atom have nothing to do with this trend? [1]

Student's response

As electronic configuration does not dictate / alter boiling points.

Examiner's comments

Candidates had to realize that all these atoms had full outer shells. This proved to be challenging for all candidates including those at grade A.

[0 marks awarded]

Q8c What colour is helium? [1]

Student's response

colourless

Examiner's comments

Most grade A candidates were able to give the correct answer of colourless for helium. It was however surprising how many candidates gave alternative descriptions for this.

[1 mark awarded]

Q8d(i) Calculate the average change in boiling point from one element to the next as you move down the group. [3]

Show your working

Student's response

$$\frac{23 + 60 + 33 + 45}{4} = 40 \cdot 25$$

40

Examiner's comments

Generally grade A candidates were able to work out the average change correctly. Some however wrongly divided by 5 instead of 4 for the number of changes. They were still able to score 3 out of 4 marks if the rest of the calculation was correct.

[3 marks awarded]

Q8d(ii) Use your answer to predict the boiling point for radon. [1]

Student's response

-68

Examiner's comments

Most grade A candidates were able to use their answers to the previous part to correctly predict the boiling point for radon.

[1 mark awarded]

Q8e Give one physical property, other than low boiling point, of the noble gases. [1]

Student's response

A full outer shell → unreactive

Examiner's comments

It was surprising to see how few candidates were able to give an alternative physical property for helium. Colourless, odourless, tasteless or insoluble in water were the physical properties expected.

[0 marks awarded]

GCSE: Double Award Science

Chemistry Unit C2: Higher Tier

Grade: A Exemplar

Q1 This question is about gas chemistry.

Q1a The atmosphere is a mixture of gases. Two of these gases are nitrogen and oxygen.

Q1a(i) Approximately what percentage of the air is **not** nitrogen or oxygen? [1]

Student's response

1%

Examiner's comments

Answers in the range 1-2% were allowed. This question was well answered.

[Mark awarded 1]

Q1a(ii) Which element is the third most abundant gas in the atmosphere? [1]

Student's response

Argon

Examiner's comments

Argon is only answer. Generally well answered.

[Mark awarded 1]

Q1b Nitrogen is a very unreactive gas, but under extreme conditions it will react with hydrogen to form ammonia.

Q1b(i) What makes nitrogen such an unreactive element? [1]

Student's response

It's triple covalent bond as it needs massive amounts of energy to break it.

Examiner's comments

The mark was awarded for triple bond. Some students found this difficult. No mark was awarded for 3 bonds.

[Mark awarded 1]

Q1b(ii) Describe the test for ammonia gas. [3]

Student's response

A rod is dipped into ammonia and held near hydrochloride acid. Smoke of ammonium chloride will be given off.

Examiner's comments

The 3 marks were stand alone marks. One mark was awarded for glass rod, a second mark was awarded for concentrated hydrochloric acid and the third mark for idea of white smoke or white fumes formed. A method error e.g. use of heat reduced maximum mark by one. A common error was to use concentrated sulfuric acid.

[Mark awarded 0]

Q1c(i) Oxygen gas can be prepared by the catalytic decomposition of hydrogen peroxide (H_2O_2). Complete the balanced symbol equation for this reaction. [2]

Student's response

$2H_2O_2 \longrightarrow 2H_2O + O_2$

Examiner's comments

The first mark is awarded for correct right hand side of equation (RHS). If this is correct then the second mark is awarded for correctly balancing the equation. If the RHS is wrong then no balancing mark can be awarded.

[Marks awarded 2]

Q1c(ii) When sulfur burns in oxygen, what colour is the flame?

Circle the correct answer. [1]

Student's response

white **orange** **blue** **yellow** **red**

Examiner's comments

Blue only correct answer.

[Mark awarded 1]

Q1c(iii) When sulfur burns in oxygen, is the oxide formed acidic, basic or neutral? [1]

Student's response

acidic

Examiner's comments

Acidic is only correct answer.

[Mark awarded 1]

Q1c(iv) When iron burns in oxygen, is the oxide formed acidic, basic or neutral? [1]

Student's response

basic

Examiner's comments

Basic is only correct answer.

[Mark awarded 1]

Q2 This question is about metals and the reactivity series.

Q2a A chemical reaction happens when small pieces of calcium are added to a beaker of water.

State **four** observations you would make for this reaction. [4]

Student's response

1. *Calcium Sinks then rises*
2. *Heat is released*
3. *Bubbles*
4. *Produces black solid*

Examiner's comments

The quality of answer in this question was generally good. The main problem arises when a student confuses their observations with what they would observe with the more reactive sodium or potassium metals. i.e. a flame being seen or the metal moving across the surface of the water. This student gets first mark for sinks and rises, second mark for heat released and third mark for bubbles. No mark awarded for black solid produced. White or grey solid formed would get mark.

[Marks awarded 3]

Q2b Write a balanced symbol equation for the displacement reaction which occurs between magnesium and zinc(II) sulfate. [2]

Student's response

$Mg + ZnSO_4 \longrightarrow MgSO_4 + Zn$

Examiner's comments

One mark is awarded for correct LHS of equation and one mark for correct RHS of equation. If the equation is wrongly balanced the maximum mark is one.

[Marks awarded 2]

Q2c A student wanted to find out the order of reactivity of four metals labelled A, B, C and D.

He carried out a series of displacement reactions and found out that:

- metal C displaced metal B but not metal D.
- metal B displaced metal A.

Which of the following correctly shows the order of reactivity of the four metals starting with the most reactive? [1]

Circle the correct answer.

Student's response

ABCD **DCBA** **CBDA** **BADC**

Examiner's comments

Only one correct answer here, DCBA. This question was well answered.

[Mark awarded 1]

Q3 This part of the question is about the extraction of iron from its ore haematite.

Q3a Given below are five equations for reactions which occur during the extraction of iron from its ore.

1 $C + O_2 \longrightarrow CO_2$

2 $CO_2 + C \longrightarrow 2CO$

3 $Fe_2O_3 + CO \longrightarrow Fe + CO_2$

4 $CaCO_3 \longrightarrow CaO + CO_2$

5 $CaO + SiO_2 \longrightarrow CaSiO_3$

Q3a(i) Balance equation **3**. [1]

$Fe_2O_3 + CO \longrightarrow Fe + CO_2$

Student's response

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

Examiner's comments

One mark awarded for correct balancing. Weaker students found this difficult.

[Mark awarded 1]

Q3a(ii) Explain why equation **2** can be described as a redox reaction. [3]

Student's response

Redox reaction occurs when both oxidation and reduction takes place at the same time. In equation 2, Carbon gains oxygen to become Carbon monoxide and so oxidation has occurred. In this equation, carbon dioxide gains more carbon which reduces oxygen and so this part of the equation is reduction.

Examiner's comments

Students found it difficult to score full marks in this question. There was one mark awarded for the explicit idea that redox is when oxidation and reduction are both happening. This student was awarded this mark. A second mark was awarded for stating that carbon is oxidized to carbon monoxide or as the student states the carbon gains oxygen. The third mark was for stating that carbon dioxide is reduced to carbon monoxide or carbon dioxide loses oxygen. The student did not gain this mark.

[Marks awarded 2]

Q3a(iii) Equations **4** and **5** occur so that acidic impurities can be removed. What is the name of the main acidic impurity? [1]

Student's response

Calcium oxide

Examiner's comments

Correct answer silica or silicon dioxide. Sand and silicon oxide were answers that were frequently given by students but awarded no marks.

[Mark awarded 0]

Q3a(iv) What is the chemical or common name for $CaSiO_3$ and how is it removed from the blast furnace? [2]

Student's response

Name: *Slag*

Method of removal: *Heating*

Examiner's comments

Name: Slag or calcium silicate gets one mark. Method of removal: tapped off or run off gets one mark.

[Mark awarded 1]

Q3b The reaction between hydrogen gas and nitrogen gas to produce ammonia gas is described as a reversible reaction.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Give **two** reaction conditions which could be changed to alter the direction of this reaction. [2]

Student's response

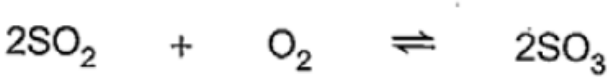
1. *increase temperature.*
2. *increase concentration of nitrogen in the air.*

Examiner's comments

The two conditions are temperature and pressure. The use of increase or decrease does not negate the mark in either case.

[Mark awarded 1]

Q3c When sulfur dioxide and oxygen react to produce sulfur trioxide, the reaction can reach a dynamic equilibrium.



Explain what is meant by a **dynamic equilibrium**. [2]

Student's response

When the rate of forward reaction is equal to the rate of the reverse reaction in a closed system.

Examiner's comments

Rates of forward and reverse reaction are equal for one mark which this student gets correct. The second mark was awarded for amounts of reactants and products remain constant. A good number of students lost this second mark by giving the idea of amounts of reactants and products being equal or the same.

[Mark awarded 1]

Q4a Name three things that all homologous series of organic molecules have in common. [3]

Student's response

1. *Same general formula*
2. *Similar chemical properties.*
3. *Show a graduation in physical properties.*

Examiner's comments

Four possible marking points. Any three of which will earn maximum marks. This student scored three marks for three correct marking points. The fourth marking point gave most difficulty. The correct answer was differ by a CH_2 unit. The mark was lost if the student gave CH_2 molecule or atom as the answer.

[Marks awarded 3]

Q4b The toxic gas carbon monoxide is formed during incomplete combustion of fuels.

What effect does carbon monoxide have on blood which causes it to be toxic to humans? [2]

Student's response

Carbon monoxide is a toxic gas as it thins our blood and reduces capacity of carrying oxygen.

Examiner's comments

The first mark is for carbon monoxide combines with haemoglobin and the second mark is for the idea that this reduces the capacity of the blood to carry oxygen. The two marks are independent of each other. This student was awarded the second mark for reducing capacity of blood to carry oxygen. The first mark was not awarded as there is no mention of combining with haemoglobin.

[Mark awarded 1]

Q4c(i) Describe what is observed when carbon dioxide is bubbled through a solution of calcium hydroxide (limewater) until carbon dioxide is in excess. [2]

Student's response

Carbon dioxide is hubbled through limewater to go from colourless to cloudy white solution. Keep reacting the carbon dioxide to go from cloudy to colourless solution.

Examiner's comments

The colourless solution becomes milky or a white precipitate forms gets one mark. When more carbon dioxide is added the precipitate disappears or a colourless solution is formed gets the second mark. The second mark can only be scored if the first marking point is correct.

[Marks awarded 2]

Q4c(ii) Name a calcium compound which is formed when carbon dioxide is bubbled through a solution of calcium hydroxide (limewater). [1]

Circle the correct answer.

Student's response

calcium oxide	**calcium hydride**	**calcium chloride**	**calcium carbonate**

Examiner's comments

Calcium carbonate is the only correct answer.

[Mark awarded 1]

Q4d Combustion of fuels containing sulfur leads to the formation of acid rain. Give three different effects of acid rain. [3]

Student's response

1. *Damage buildings especially ones made from limestone*
2. *Damage vegetation*
3. *Kill fish in lakes and rivers.*

Examiner's comments

There are three marking points here. The first marking point is the idea of damaging buildings/statues/named limestone features. A number of students used the term erodes in this part of the answer and this was not accepted as it is a physical process.

The second marking point is the killing of fish in rivers and lakes. Killing marine life was not accepted as a correct answer.

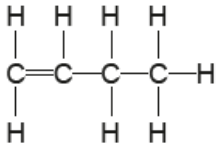
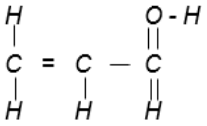
The third marking point is damaging vegetation or defoliating trees. Acidifying soil was not an acceptable answer on its own. The effect of acidified soil on vegetation was needed for the mark.

[Marks awarded 3]

Q5 This question is about alkenes, alcohols and polymers.

Q5a Complete the table below by filling in the blank spaces. [4]

Student's response

Name	Molecular formula	Structural formula	Physical state at room temperature
but-1-ene	C_4H_8		*Gas*
propan-1-ol	C_3H_7OH		liquid

Examiner's comments

This question was generally well answered. The structure of propan-1-ol was the part which gave most difficulty.

[Marks awarded 3]

Q5b(i) What is the molecular formula of the product from the reaction between ethene and hydrogen?. [1]

Student's response

C_2H_6

Examiner's comments

This question was generally well answered. The full equation for the reaction was also an acceptable answer.

[Mark awarded 1]

Q5b(ii) What product is formed when ethene reacts with steam? [1]

Student's response

Ethanol

Examiner's comments

This question was generally well answered. The full equation for the reaction was an acceptable answer.

[Mark awarded 1]

Q5b(iii) What type of reaction occurs when ethene reacts with hydrogen or with steam? [1]

Student's response

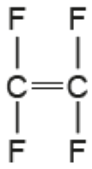
Cracking

Examiner's comments

The expected answer was Addition so the candidate was not credited with any marks.

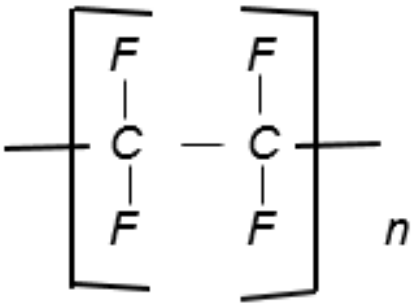
[0 marks awarded]

Q5c The structure of the monomer tetrafluoroethene is given below:



Draw the structure of the polymer polytetrafluoroethene (also known as PTFE). [2]

Student's response



Examiner's comments

One mark was awarded for the correct repeating unit and the other mark was awarded for the brackets and the 'n' being in the correct place. This candidate scored full marks.

[2 marks awarded]

Q6a Give the empirical formula for each of the following compounds:

Q6a(i) H_2O_2 [1]

Q6a(ii) $C_6H_{12}O_6$ [1]

Q6a(iii) C_3H_8 [1]

Student's response

(i) *HO*

(ii) *CH_2O*

(iii) *C_3H_8*

Examiner's comments

(i) This question proved difficult for some candidates. H_1O_1 or 2HO were not acceptable answers. However there was an ecf mark given in part (ii) if the same error was made.

[Mark awarded 1]

(ii) $C_1H_2O_1$ and $6CH_2O$ are accepted here if the same error has been penalised in part (i).

[Mark awarded 1]

(iii) This part of the question gave less difficulty.

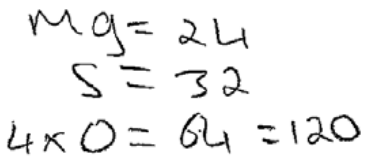
[Mark awarded 1]

Q6b A sample of hydrated magnesium sulfate, $MgSO_4.xH_2O$, was heated to constantmass. Only 48.8% of the original mass remained. [1]

(relative atomic masses: H = 1, O = 16, Mg = 24, S = 32)

Q6b(i) Calculate the relative formula mass (M_r) of $MgSO_4$. [1]

Student's response



120

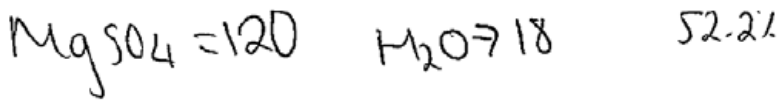
Examiner's comments

This part of the question was generally well answered.

[Mark awarded 1]

Q6b(ii) Use your answer to **(b)(i)** and the information given in the question to calculate the relative formula mass (M_r) of $MgSO_4.xH_2O$. [2]

Student's response



138

Examiner's comments

This proved to be a difficult question. There was an ecf on this part if (b)i was incorrect and it was also possible to gain a correct method mark for showing correct working.

[Mark awarded 0]

Q6b(iii) Using your answers to **(b)(i)** and **(b)(ii)**, calculate the value of x.. [2]

Student's response

2

Examiner's comments

This proved to be a difficult question. There was an ecf applied if (b)(i) or (b)(ii) or both were incorrect. A method mark could also be gained if correct working was shown.

[Mark awarded 0]

Q7a Electrolysis is used in the industrial extraction of aluminium from alumina using graphite electrodes.

Q7a(i) Name the ore which is purified to make alumina. [1]

Student's response

Bauxite

Examiner's comments

This question was generally well answered.

[Mark awarded 1]

Q7a(ii) Describe the industrial extraction of aluminium.

Your answer should include descriptions and explanations, as appropriate, of:

- what is added to the alumina and why
- the reaction that happens at the **cathode**
- how the aluminium is removed
- why the anode needs to be replaced periodically

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

Student's response

What is added to the alumina and why:

Alumina is dissolved in molten cryolite which is easier than melting it as alumina has very high melting point of 2072ºC. Aluminium ions and oxide ions are free to move and carry charge.

The reaction that happens at the cathode:

The cations are attracted to the cathode. The cations here are the Aluminium ions. These ions form at cathode and so reduction occurs at the cathode.

How the aluminium is removed:

The aluminium oxide is placed in a steel cell and electricity moves in and out of the molten aluminium oxide due to the solid graphite electrodes. Once all oxygen atoms joins to form gas, aluminium is left in the crucible.

Why the anode needs to be replaced periodically

Anode needs to be replaced periodically as it corrodes due to its reactions with oxygen. Carbon + oxygen ⟶ carbon dioxide. [6]

Examiner's comments

Many grade A students gained at least 5 indicative points which got them into the middle band in this question. In the first section the indicative point relating to the idea of lowering operating temperature gave most difficulty and the mark scheme was adjusted to allow more students to gain this indicative point. The reaction that happens at the cathode also gave some difficulty. Some students were giving a generic answer without specifically talking about aluminium ions gaining electrons to form aluminium.

[Marks awarded 2 (4 indicative points)]

Q7a(iii) Write a half equation for the reaction that happens at the anode during the industrial extraction of aluminium. [3]

Student's response

$2O^{2-} \longrightarrow 2O + 4\bar{e}$

Examiner's comments

Students found this question difficult. One mark was awarded for reactants which this student gained. One mark was awarded for products and if reactants and products were correct a third mark could be gained for correct balancing of the equation.

[Mark awarded 1]

Q7a(iv) Explain why it is better to recycle aluminium rather than extracting it from its ore. [3]

Student's response

Because recycling aluminium helps to save money, resources and time and also prevents waste going to landfill.

Examiner's comments

There are four marking points here. Any three of which got the student full marks. There was no mark for being cheaper unless it was related to idea of saving electricity or energy. This student got one mark for saving resources and one mark for reducing waste.

[Marks awarded 2]

Q7b Electrolysis can be used to decompose molten salts such as sodium bromide.

Complete the table to show the products formed, at the cathode and anode, when molten sodium bromide is decomposed using electrolysis. [2]

Student's response

Electrode	Product formed
cathode (-)	*Sodium*
anode (+)	*bromine*

Examiner's comments

The candidate named both products at the cathode and anode correctly.

[2 marks awarded]

Q8 This question is about energy changes during chemical reactions.

Q8a Chemical reactions have an activation energy. What is meant by the term **activation energy**? [2]

Student's response

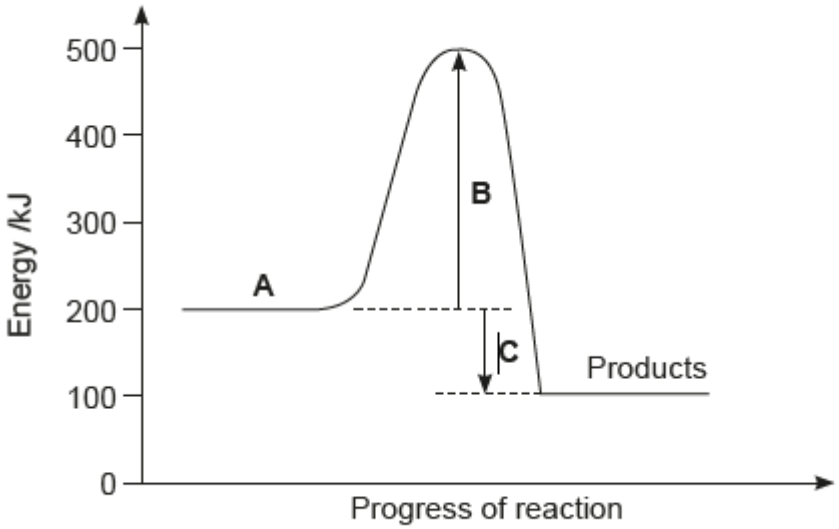
The minimum amount of energy needed for a reaction to occur.

Examiner's comments

The most common error in answers to this question was where students said the amount of energy needed for the reaction to occur rather than the minimum energy needed. This cost the student the first mark. It was still possible for students to gain the second mark.

[Mark awarded 2]

Q8b A reaction profile diagram is shown below:



Q8b(i) What do the labels **A**, **B** and **C** represent? [3]

Student's response

A = *Reaction*

B = *Amount of energy*

C = *Amount of product formed*

Examiner's comments

This student gained one mark for A = reactants. The second mark is for activation energy and the third mark is for energy change/energy released/energy given out.

[Mark awarded 1]

Q8b(ii) Does the reaction profile diagram represent an exothermic reaction, an endothermic reaction or both? [1]

Student's response

Exothermic reaction

Examiner's comments

This question was generally well answered.

[Mark awarded 1]

Q8b(iii) From the energies given on the y axis, calculate the energy change for the reaction. [1]

Circle the correct answer.

Student's response

+500 kJ **+300 kJ** **+100 kJ** **−100 kJ** **−400 kJ** **−500 kJ**

Examiner's comments

This question was generally well answered.

[Mark awarded 1]

Q8b(iv) If a catalyst was added, which of the three energies listed below would get smaller? [1]

Circle the correct answer or answers.

Student's response

activation energy **energy of reactants** **energy of products**

Examiner's comments

This question was generally well answered. This candidate lost the mark. The correct answer is activation energy.

[Mark awarded 0]

GCSE: Double Award Science

Chemistry
Unit 7: Practical Skills
Booklet A
Higher Tier

Grade: A Exemplar

Q1a When solids are added to hydrochloric acid, a temperature change may occur and a gas may be produced.

You are provided with three solids labelled **X**, **Y** and **Z**.

Use the table below to record the results of experiments 1, 2 and 3 detailed below. [4]

Carry out the following steps.

Experiment 1

1. Using the measuring cylinder, measure 10 cm^3 of hydrochloric acid and place in a boiling tube.
2. Using the thermometer, measure the temperature of the hydrochloric acid and record this temperature in the table. Remove the thermometer.
3. Add all of solid X to the boiling tube and stir using the thermometer. Measure the highest or lowest temperature achieved and record this temperature in the table.
4. Record in the table if a gas is produced (Yes/No).
5. Calculate the temperature change and record this in the table.

Experiment 2

Repeat steps 1 – 5 as detailed for experiment 1, using solid Y in step 3.

Experiment 3

Repeat steps 1 – 5 as detailed for experiment 1 using solid Z in step 3.

Student's response

Experiment	Temperature of hydrochloric acid / ºC	Highest or Lowest temperature achieved/ ºC	Temperature change/ ºC	Gas produced? Yes / No
Experiment 1 using solid **X**	*19*	*26*	*7*	*Yes*
Experiment 2 using solid **Y**	*19*	*15*	*-4*	*Yes*
Experiment 3 using solid **Z**	*19*	*19*	*0*	*No*

Examiner's comments

Grade A candidates achieved full marks in this question. Experiment 1 resulted in an exothermic reaction when sodium carbonate was reacted with hydrochloric acid. 1 mark was awarded for obtaining a temperature increase within the range allowed (3 to 7^0C).

Experiment 2 resulted in an endothermic reaction when sodium hydrogencarbonate was reacted with hydrochloric acid. 1 mark was awarded for obtaining a temperature decrease within the range allowed (-1 to -5^0C).

Experiment 3 resulted in no net temperature change when sodium chloride was reacted with hydrochloric acid. 1 mark was awarded for obtaining no change in temperature. If a change of -1^0C was obtained, credit was awarded as a slight decrease in temperature can be observed.

For the three experiments gas was produced with experiments 1 and 2 only. Fizzing was observed with both experiments 1 & 2, indicating the production of a gas. No fizzing was observed with experiment 3. For 1 mark to be awarded all three correct answers were needed i.e. experiment 1 – yes, experiment 2 - yes and experiment 3 – no.

[Marks awarded 4]

Q1b Which experiment(s) 1, 2 or 3 involved an exothermic reaction? [1]

Student's response

1

Examiner's comments

Grade A candidates achieved full marks in this question and were able to identify experiment 1 as being an exothermic reaction as this was the only reaction that involved a temperature increase.

[Marks awarded 1]

Q2a You are provided with sulfuric acid and compound **A**.

Describe the appearance of compound **A** and of sulfuric acid. [4]

Student's response

compound **A**: *Green solid*

sulfuric acid: *colourless solution.*

Examiner's comments

Grade A candidates were able to describe the appearance of compound A as a green solid. In this response 1 mark was awarded for the colour green and 1 mark was awarded for it being a solid. Powder was also accepted. Candidates describing the compound as green-blue were not awarded credit. Shades of green, light or dark were allowed.

Grade A candidates were able to describe the appearance of sulfuric acid for compound B, as a colourless solution. In this response 1 mark was awarded for colourless and one mark awarded for solution. Liquid was also accepted as an alternative to solution. Often candidates used the term clear to describe the colour but clear was not accepted in place of colourless, as clear does not describe if something has colour or not. A coloured solution can be clear.

[Marks awarded 4]

Q2b Using the measuring cylinder, measure 25 cm^3 of sulfuric acid and place in the 100 cm^3 beaker. Add one spatula measure of compound **A** to the beaker. Stir using the glass rod until there is no further change. Record all your observations. [3]

Student's response

Green solid dissolved, and turned the solution from colourless to blue. Gas was also produced as the solution fizzed.

Examiner's comments

The majority of grade A candidates were able to identify the following 3 key observations; Firstly, that the green solid disappeared/dissolved when added to the sulfuric acid. Secondly, that a blue solution was formed or that the colourless sulfuric acid solution turned blue when it reacted with compound A. It should be noted that reference to the solution turning blue had to be made (turning green to blue was not enough for credit). Thirdly, that a gas was released – idea of bubbles/effervescence/fizzing.

[Marks awarded 3]

Q2c(i) Six compounds are listed below.

Circle the compound which could be **A**. [1]

Student's response

calcium sulfate	*calcium carbonate*	*copper(II) chloride*
copper carbonate	*potassium chloride*	*potassium sulfate*

Examiner's comments

The majority of grade A candidates were able to identify compound A as being copper (II) carbonate. Grade A candidates either knew that copper (II) carbonate was a green coloured compound or they understood that copper is a transition metal and transition metals form coloured compounds. Furthermore they had noted that a gas was released when compound A was reacted with sulfuric acid and therefore only copper (II) carbonate would produce a gas and not copper (II) chloride when reacted with sulfuric acid.

[Marks awarded 1]

Q2c(ii) Explain your answer to part **(c)(i)** based on your observations from parts **(a)** and **(b)**. [2]

Student's response

Copper (II) carbonate is a green solid and when mixed with sulfuric acid, it becomes copper (II) sulfate (which is blue) and as we can see from my observation the colour changed to blue.

Examiner's comments

Candidates were asked to validate their answer to Q2c(i) based on their observations. In this response the first mark was awarded for correctly identifying that copper compounds are coloured compounds or that compound A was a green solid. An explanation based on the solution turning blue when the compound was added to the sulfuric acid was also accepted. An incorrect colour given for the compound was penalised.

The second mark was not awarded, as the candidate did not provide an explanation for how they knew the compound was a carbonate. To achieve this second mark the idea that a gas (carbon dioxide) is given off when carbonates react with acid or evidence of fizzing/bubbling/effervescence during the reaction was required.

An incorrect gas identified as being formed, e.g. hydrogen, was penalised. The idea of the reaction being vigorous was also accepted for 1 of the 2 marks available, but very few candidates provided this as an explanation.

[Marks awarded 1]

GCSE: Double Award Science

Unit 7: Practical Skills
Chemistry
Booklet B
Higher Tier

Grade: A Exemplar

Q1 You have been given a bottle containing a liquid alkane and a bottle containing a liquid alkene. The labels have fallen off the bottles.

Q1a Describe how you would carry out a chemical test on both samples to identify which sample was the alkene and which was the alkane. Name any reagents used and describe what you would observe. [4]

Student's response

To test for the alkane, add it to bromine solution. The bromine solution should stay orange if an alkane is present. Add the second bottle of liquid to a different bromine solution. If an alkene is present, the bromine will change from orange to colourless.

Examiner's comments

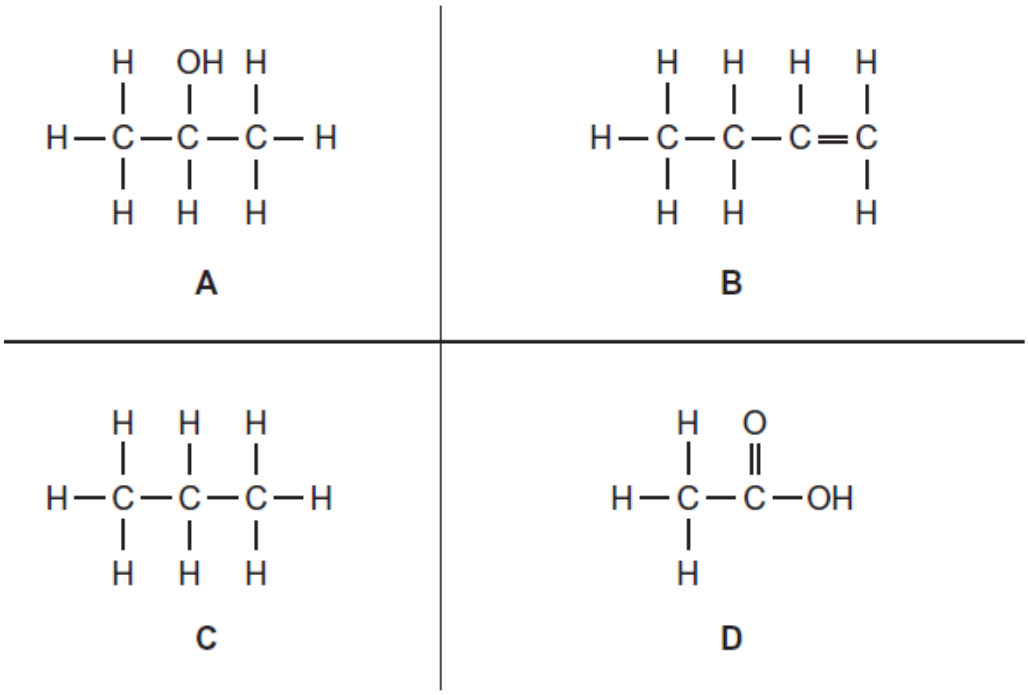
4 marking points were available for this question. Examiners were looking for the idea of bromine water (or solution) being added to a sample of an alkene or alkane to distinguish between the two of them. Examiners were also looking for the initial colour of the bromine water – i.e. orange**,** and that when added to an alkene the bromine water became colourless**,** and when added to the alkane the bromine water remained orange. In this response the candidate achieved one mark for stating bromine solution was added, two marks for stating that the bromine solution stayed orange (1 for the original colour orange and 1 for staying orange when added to the alkane). The fourth mark was awarded for stating that when added to the alkene the bromine solution changed from orange to colourless.

Often marks were lost for simply stating testing with 'bromine' instead of 'bromine water', describing the colour of bromine water as red-brown and using the term clear for colourless. On occasions the test for the alkene and alkane were explained the wrong way round – error carried forward was allowed after the first test was marked incorrect to avoid penalising candidates multiple times.

Grade A candidates may not have scored all 4 marks in this question but they clearly knew the basis for differentiating between an alkene and alkane.

[Marks awarded 4]

Q1b The structures of four organic compounds are shown below:



Identify which of the compounds (**A**, **B**, **C** or **D**) would react with sodium carbonate. [1]

Student's response

B

Examiner's comments

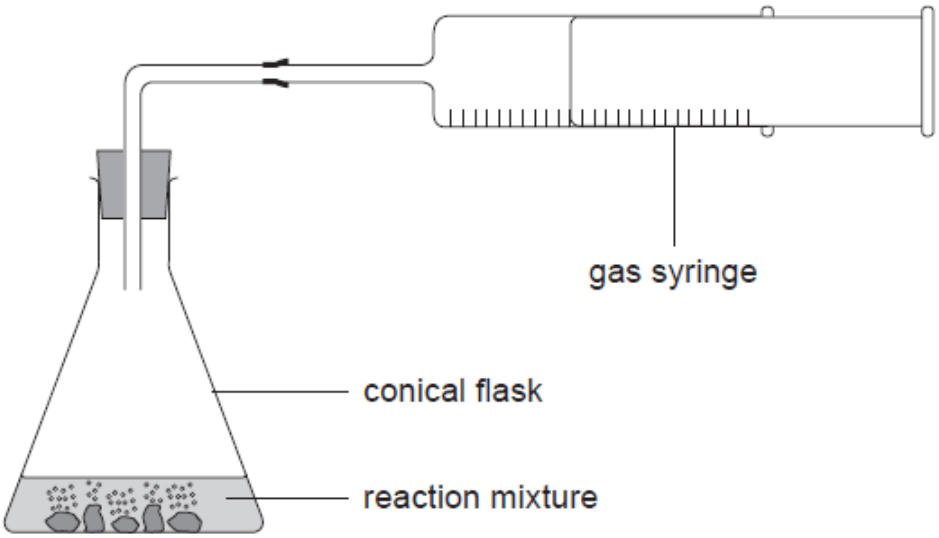
An incorrect answer was given for this question, however, the majority of Grade A candidates correctly identified structure D as being a carboxylic acid which could react with a metal carbonate - in this case sodium carbonate.

[Marks awarded 0]

Q2 When calcium carbonate reacts with hydrochloric acid the following reaction occurs:

calcium carbonate + hydrochloric acid ⟶ calcium chloride + water + carbon dioxide

A group of students wanted to measure the rate of reaction between calcium carbonate and hydrochloric acid. They set up the apparatus shown below and measured the volume of gas produced over a period of time.



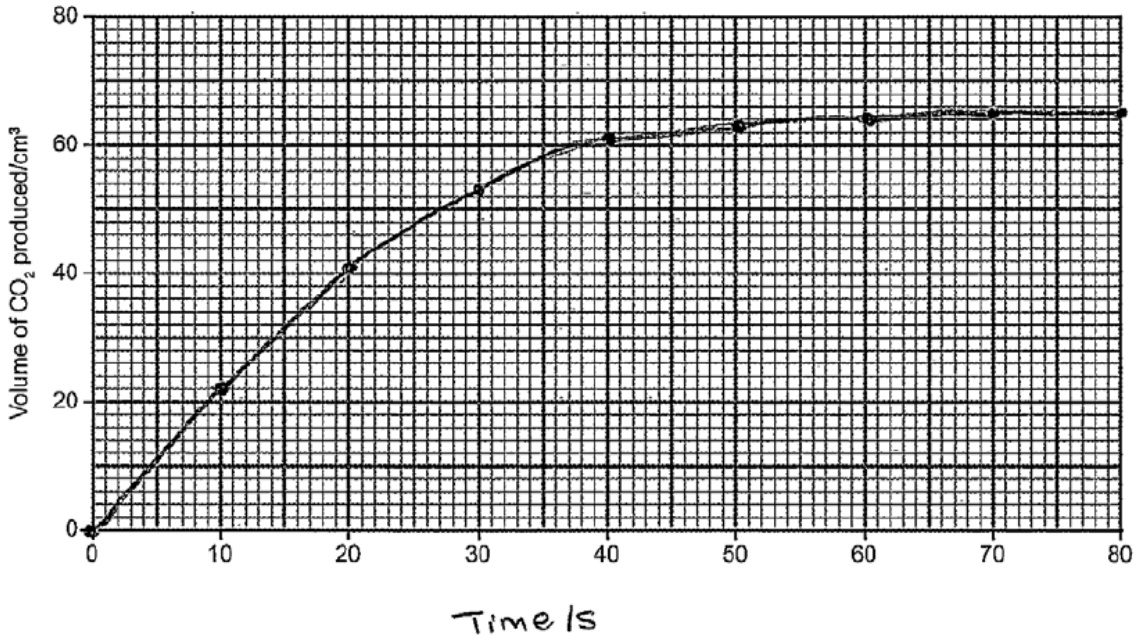
The following results for the experiment were obtained:

Time/s	0	10	20	30	40	50	60	70	80
Volume of CO_2 produced/cm^3	0	22	41	53	61	63	64	65	65

Q2a On the grid below:

- label the x-axis;
- plot a graph to show how the volume of carbon dioxide gas produced changes with time when calcium carbonate reacts with hydrochloric acid. [4]

Student's response



Examiner's comments

The graph was correctly labelled including the correct units. 1 mark was awarded for labeling of the axis. All data points were correctly plotted gaining 2 marks (more than 7 of the 9 points had to be plotted correctly to gain 2 marks. 1 mark could be awarded if between 4 and 6 were plotted correctly).

A further mark was awarded for joining the points in a suitable manner (a smooth curve / line was expected - a ruler drawn line was not accepted). The drawing of the line for this candidates graph could appear ruler drawn, especially around 0-30s data points. However on further examination it was deemed borderline between a smooth curve and a ruler drawn line so a mark was awarded. Grade A candidates should be able to achieve full marks in this question.

Where marks were lost was not labeling the axis to include the units or more frequently not drawing a smooth curve, but instead a ruler drawn or point-to-point line. It should also be noted the graph was expected to pass through the origin.

[Marks awarded 4]

Q2b From your graph, how long did it take to produce 48 cm^3 of the gas? [1]

Student's response

25.5 s

Examiner's comments

The candidate correctly determined from their graph the time taken to produce 48cm^3 of CO_2. The expected answer was 25 seconds, however a tolerance of ± 1 second was allowed. This candidate's answer was 25.5 seconds, therefore falling within the acceptable range and so awarded the mark. Majority of candidates were able to determine this time correctly.

[Marks awarded 1]

Q2c During what period of time (A, B, C or D) was the reaction rate the fastest? [1]

A 0—20 seconds

B 21—40 seconds

C 41—50 seconds

D 61—80 seconds

Student's response

A

Examiner's comments

The candidate correctly identified the fastest part of the reaction to be between 0-20 seconds (answer A). The majority of candidates were able to identify this correctly.

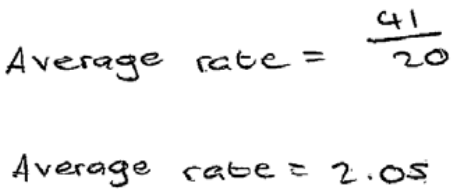
[Marks awarded 1]

The average rate of this reaction can be calculated using the following equation:

$$\text{Average rate} = \frac{\text{Volume of gas produced}}{\text{Time}}$$

Q2d Calculate the average rate of the reaction for the first 20 seconds. [2]

Student's response



2.05 cm^3/s

Examiner's comments

The formula to use for calculating rate was provided in the question, Rate = 1 / Time. 1 mark was awarded for the method of calculation for the average rate of reaction for the first 20 seconds and 1 mark for the correct answer. Candidates could have taken the value of CO_2 produced in the first 20 seconds from the table provided – 41 cm^3, or from their graph. Taking the volume of CO_2 and dividing it by the time, gave the average rate of reaction to be 2.05 cm^3/s.

It should be noted that if incorrect values were used for the volume of gas produced or the time period, for example 65cm^3/s / 20s, 1 ECF mark could be awarded for the calculated answer. Grade A candidates were scoring full marks in this question.

[Marks awarded 2]

Q2e The student repeated the experiment at a higher temperature and found that the reaction was faster. Explain, in terms of collision theory, the effect of increasing the temperature on the rate of reaction. [3]

Student's response

The rise in temperature means an increase in heat energy. This allows particles to move around faster, causing more collisions and therefore more reactions.

Examiner's comments

In this response to explain collision theory with regards to the effect of increasing the temperature the candidate scored one mark for stating there was an increase in energy and a second mark for stating that this allowed the particles to move around faster. The candidate went on to explain that the faster movement caused more collisions and therefore more reactions. In order to have gained a third mark the word 'successful' collisions was needed (or more energetic collisions). Stating 'more collisions' was not enough for credit.

A mark could also have been awarded for stating more of the particles now possess the necessary activation energy, but very few candidates described this.

4 correct marking points – any 3 of these could gain a mark.

Another area where credit was not awarded was stating 'more energy produced' or 'there was a higher energy' – the 'particles' having more energy was required.

[Marks awarded 2]

Q3 Hydrogen gas can be prepared in the laboratory by reacting zinc metal and dilute hydrochloric acid. This gas can be collected over water.

Q3a Describe how you would set up and use the apparatus needed to prepare and collect hydrogen gas over water using zinc and hydrochloric acid. Describe how you would test the gas to show that it is hydrogen. [6]

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

Student's response

Preparation and collection of hydrogen gas:

Place a piece of zinc metal into dilute hydrochloric acid and swirl once to ensure it is fully emmersed in the acid. Apply a gas syringe to the bung. (Which is sealed to prevent loss of gas) ensure this stage is ready immediately after the zinc is introduced connect the syringe to a delivery tube where the gas can be collected over water. Hydrogen will rise to the top where it can be collected.

Test for hydrogen gas:

Apply a lighted splint to the gas, a squeaky pop will indicate the presence of hydrogen.

Examiner's comments

For the preparation and collection of hydrogen gas 8 indicative points in total were available. 3 indicative points were available for the preparation of hydrogen gas. 1 indicative point for the preparation/reaction vessel containing the zinc and hydrochloric acid. Suitable reaction/preparation vessels allowed were a conical flask or boiling tube.

A 2nd indicative point for the idea of a bung or stopper being placed in the preparation/reaction vessel. A 3rd indicative point was for a delivery tube being attached to the preparation/reaction vessel. 3 indicative points were available for the collection of the gas. It should be noted that in the information provided at the beginning of the question candidates were told that the collection of gas was over water.

1 indicative point for carrying out the collection in a trough/bowl/basin of water. A 2nd indicative point for the collection of gas in a gas jar/test tube/boiling tube or measuring cylinder.

A 3rd indicative point for the gas jar (or other) being filled with water. 2 further indicative points were available: 1 for using a thistle funnel for transferring the hydrochloric acid to the preparation/reaction vessel or for a beehive shelf placed in the trough of water and; also 1 indicative point for connecting the delivery tube from the preparation/reaction vessel to a trough of water or collection vessel.

The final 2 indicative points were awarded for the correct explanation of the test for hydrogen gas: 1 indicative point for applying a lit splint to a sample of the gas and a 2nd indicative point for a 'squeaky pop'.

Overall 10 indicative points were available.

In this response the candidate was awarded an indicative point for the idea of a bung being used. Although they stated a piece of zinc metal was placed into hydrochloric acid, they did not give details for the preparation vessel and therefore were not awarded an indicative point for this. The candidate was not awarded any further credit as they used a gas syringe to collect the hydrogen gas. The candidate was awarded the 2 available indicative points for the test for hydrogen.

This meant overall the candidate was awarded 3 indicative points which equated to 2 out of the 6 marks available: 2-4 indicative points = 1-2 marks.

No deduction was made for the quality of written communication as it was deemed acceptable with the inclusion of appropriate scientific terms, so the full 2 marks awarded. Grade A candidates tended to score between 4 and 6 marks in this question.

[Marks awarded 2]

Q3b Identify a precaution, other than wearing safety goggles, which you would take to ensure that the reaction between zinc and hydrochloric acid was carried out safely and explain why you would take this precaution. [2]

Student's response

Precaution: *peform in a fume cupboard*

Explanation: *hydrogen is highly flammable*

Examiner's comments

The mark scheme was widened to accommodate the range of answers given by candidates. In this response 1 mark was awarded for carrying out the reaction in a fume cupboard and 1 for the explanation that hydrogen is highly flammable. Other answers were also deemed acceptable if applicable to the experimental setup.

[Marks awarded 2]

Q3c The reaction of zinc with hydrochloric acid can also be carried out with the addition of a catalyst. What is meant by the term catalyst? [1]

Student's response

A catays speeds up the rate of reaction without being used up.

Examiner's comments

It should be noted that this question asked for 'what is meant by the term catalyst' and not 'how it works'. This response scored 1 mark for stating that a catalyst speeds up a reaction and a second mark for it not being used up. Majority of candidates gained two marks in the question. Stating 'without being used' was not enough for credit - 'without being used up' was required. Answers with regards to lowering the activation energy were not accepted.

[Marks awarded 2]

Q3d Name one metal, other than zinc, which could be used with hydrochloric acid to safely prepare hydrogen. [2]

Student's response

Aluminium

Examiner's comments

1 mark awarded for stating aluminium as an acceptable alternative. Magnesium, aluminium and iron were acceptable answers.

[Marks awarded 1]

Q4 This question is about the identification of ions and compounds using chemical analysis.

Q4a **T** is a white solid which is slightly soluble in water.

When a solution of **T** reacts with **sulfuric acid** it forms a white solid, **U** and no gas is given off.

A flame test on **U** produced a brick-red flame.

Q4a(i) Name the metal ion present in **U**. [1]

Student's response

Copper sulfute

Examiner's comments

This question asked for the metal ion present in the white solid U. The question did not ask for the name of U. The information presented in the question stated that the metal ion present in U produced a brick-red flame. This should have led candidates to recall their cation flame tests in which calcium (Ca^{2+}) is the metal-ion, which produces a brick red colour. A high percentage of candidates failed to identify this metal ion.

[Marks awarded 0]

Q4a(ii) Suggest the formula for **U**. [1]

Student's response

Ca

Examiner's comments

This question asked for the formula of U. In order to determine the formula of U, candidates were expected to use the information in the question. The cation part of the compound was identified as calcium in part (a) (i). In order to identify the anion part of the compound it was stated that when a solution of T reacted with sulfuric acid, a white solid U was formed. The Anion formed from sulfuric acid would be sulfate so therefore compound U would be calcium sulfate, and the formula $CaSO_4$. As the question asked for the formula to be given, writing calcium sulfate did not gain credit.

It should be noted that if a candidate gave the incorrect metal ion in part (a) (i) then ECF could be applied if the formula was correct in part (a) (ii). However, no coloured compounds were allowed as in the information provided in the question, stated U was a white solid. Metal ions Na, Li, K, Mg, Ba, Pb & Al were allowed. Copper compounds were often observed as incorrect answers.

[Marks awarded 0]

Q4a(iii) Suggest a chemical name for **T**. [1]

Student's response

copper

Examiner's comments

In order to identify T, the question stated that when U was formed no gas was given off. Therefore when a metal hydroxide reacts with an acid, a salt and water are formed with no gas being given off. The same applies for oxides. If the cation identified for U in 4a(i) was calcium then Calcium hydroxide or calcium oxide would have been suitable suggestions for T. Metal carbonates and metals on their own would produce gases so therefore this should have led candidates to identify the metal hydroxide or metal oxide as being the possible compound. Error carried forward was allowed in this question if the wrong ion identified in 4a(i) was used.

[Marks awarded 0]

Q4a(iv) If T had been added to dilute nitric acid instead of dilute sulfuric acid what different observation would have been made? [1]

Student's response

orange flame

Examiner's comments

In order to identify the difference between a reaction of compound T with dilute nitric acid and dilute sulfuric acid, the salts formed would have been calcium nitrate and calcium sulfate. Calcium sulfate is only slightly soluble in water whereas calcium nitrate is soluble in water. The difference between the two reactions would therefore have been that no precipitate would have been observed with calcium nitrate. No white solid observed or colourless solution formed was also acceptable.

[Marks awarded 0]

Q4b **V** is a black solid which does not dissolve in water.

V can be reduced, using hydrogen to give the metal element **W**.

V also reacts with sulfuric acid to form a blue solution.

When this blue solution is evaporated a blue solid **X** remains.

When **X** is heated to constant mass a white solid, **Y** is formed.

From the information provided deduce:

Q4b(i) the chemical name for **V**. [1]

Student's response

Hydrated copper oxide

Examiner's comments

To identify V, the question stated that V was a black solid, which did not dissolve in water. This should have prompted candidates to identify V as Copper (II) oxide/copper oxide. Here, the candidate did not score credit as they stated the compound to be 'hydrated' copper oxide. The mark was lost for the word hydrated.

[Marks awarded 0]

Q4b(ii) the name of the metal element **W** formed when **V** is reduced using hydrogen. [1]

Student's response

copper

Examiner's comments

Candidate correctly identified the name of metal element W.

The question stated that when V was reduced using hydrogen, metal element W was formed. The process of reduction involves the removal of oxygen; therefore copper oxide would be reduced to copper (the metal element W). The candidate answered this question correctly. Although part 4b(i) had been marked incorrect due to the word 'hydrated' the candidate was still able to state that copper oxide would be reduced to copper.

[Marks awarded 1]

Q4b(iii) the full chemical name for **X**. [1]

Student's response

Anhydrous copper oxide

Examiner's comments

In order to identify chemical X, the question stated that when V reacted with sulfuric acid a blue solution formed. This should trigger the idea that the solution is copper sulfate, which is a blue solution. When this blue solution was evaporated a blue solid, X remained. Copper sulfate should be identified as being X. The fact that the solid was blue and applying knowledge of water of crystallisation this would be hydrated copper sulfate /hydrated copper (II) sulfate. As the question asked for the full chemical name to be given, giving the formula $CuSO_4.5H_2O$ was not awarded credit.

[Marks awarded 0]

Q4b(iv) the formula for **Y**. [1]

Student's response

$CuSO_4$

Examiner's comments

Candidate correctly identified the formula for Y. Solid Y, a white solid was produced when solid X was heated to a constant mass suggesting that the water was removed from the hydrated copper sulfate. This would then leave anhydrous copper sulfate. The formula for anhydrous copper sulfate is $CuSO_4$. As the formula of Y was required, writing the chemical name 'anhydrous copper sulfate' was not awarded credit.

[Marks awarded 1]

Overall candidates struggled with question 4 even at grade A standard.

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