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Examiners' Report
June 2018

GCSE Chemistry 1CH0 2H

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Introduction

This examination paper was the first of this series for the Chemistry Higher tier, graded 9-1. This paper, like all the Separate Science examinations, contains ten questions giving a total of 100 marks. Six of these questions also appear on the Combined Science Chemistry Higher tier paper.

This paper also has Combined Science Chemistry questions in common with the Foundation papers, totalling 16 marks. These overlap items are the whole of question 2 and the first three items of question 3. There are also 11 marks of Separate Chemistry questions in common with the Separate Chemistry Foundation tier paper. These overlap items are the whole of question 4.

The paper made use of a variety of question types suitable for candidates at this level; multiple choice, calculations and short answer questions being the frequent types. The paper contained two extended open response questions (6-marks), but 4-mark questions will feature more prominently in future papers. As with the other Chemistry papers, a minimum of 20% of the marks were for maths, a minimum of 15% for testing practical skills and a maximum of 15% on knowledge in isolation (recall) questions.

Question 1 (a)

Generally well answered with most candidates able to score 1 or 2 of the 2 marks available.

A question very similar to this has appeared on many papers in the previous specification where they performed well. Likewise on this occasion it was pleasing to see that many candidates appreciated that as a result of the cooling Earth and its atmosphere that the water vapour would condense, fall as rain and form the seas and oceans.

Common errors, omissions, misconceptions:

Many candidates failed to mention the Earth cooling and simply mentioned formation of oceans to score just 1 mark. Sometimes this was accompanied by an incorrect reference to the Earth getting warmer, sometimes linked with global warming. Some candidates thought that as volcanic activity diminished, the amount of water vapour going into the atmosphere decreased and so the amount of water vapour in the atmosphere decreased. Others thought that the plants starting to grow on the Earth's surface used up the water vapour.

1 The Earth's atmosphere contains several gases.

(a) Figure 1 shows the relative amounts of gases thought to be in the Earth's early atmosphere.

gas	relative amount in Earth's early atmosphere
oxygen	small
carbon dioxide	large
nitrogen	small
water vapour	large

Figure 1

The amount of water vapour in today's atmosphere is much less than the amount in the Earth's early atmosphere.

Explain why the amount of water vapour in the atmosphere has decreased.

(2)

The amount of water vapour has decreased as the ~~[illegible]~~ most of the water vapour condensed forming oceans.

ResultsPlus
Examiner Comments

There is a correct reference to 'water vapour condensed forming oceans'. However, there is no reference to the Earth cooling, so this limited the score to 1 mark only.

ResultsPlus
Examiner Tip

The number of marks available to the question indicates the number of points required in the response to gain full credit. The changes in the chemistry of the atmosphere were a key feature of the previous specification and remains in this new specification. Use the past examination papers to practise this area of the specification.

1 The Earth's atmosphere contains several gases.

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water vapour	large

Figure 1

The amount of water vapour in today's atmosphere is much less than the amount in the Earth's early atmosphere.

Explain why the amount of water vapour in the atmosphere has decreased.

(2)

The ~~we~~ earth cooled down so the water vapour in the air condensed into water to form oceans.

ResultsPlus
Examiner Comments

This response scored 2 marks.

There are correct references made to the 'Earth cooled down' and 'water vapour... condensed... to form oceans'.

Question 1 (b) (i)

Generally very well answered with most candidates able to score the 2 marks available.

A question very similar to this has appeared on many papers in the previous specification where candidates performed well. This calculation was quite straightforward taking the difference in volume and converting that into a percentage.

Common errors, omissions, misconceptions:

Some candidates simply took the 40 divided by 50 and converted that into a percentage giving the value of 80% and failed to relate that back to the first line where it stated that the apparatus was used to find the percentage of oxygen in dry air. However, about half the candidates carried out a correct calculation to obtain a value of 20%. Some carried out both the correct (to give 20%) and the incorrect (to give 80%) calculations but did not then commit themselves. For that they were not credited with full marks. In a very few cases, candidates obtained a final answer of 25% (they had mistakenly divided by 40, not 50, in their calculation).

(i) The following results were obtained

initial volume of air in apparatus = 50 cm^3

final volume of gas in apparatus = 40 cm^3

Calculate the percentage of oxygen in this sample of dry air.

(2)

$\frac{40}{50} = \frac{4}{5} = 0.8$

20%

100% - 80% = 20%

percentage oxygen in the air = 20%

ResultsPlus
Examiner Comments

This response scored the 2 marks available.

A correct final answer of 20% scored. There are two ways of calculating this value. In this method, the candidate has calculated the percentage of gas remaining in the apparatus and then subtracted this from 100, to arrive at the percentage of oxygen in the sample of dry air.

(i) The following results were obtained

initial volume of air in apparatus = 50 cm^3

final volume of gas in apparatus = 40 cm^3

Calculate the percentage of oxygen in this sample of dry air.

(2)

$\frac{40-50}{40} \times 100 = -25$

percentage oxygen in the air = 25%

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Examiner Comments

A typical response which scored 1 mark only.

One mark was credited for a correct subtraction of the initial and final volumes to find the difference giving '40 – 50' (the sign can be ignored, namely -25%). The expression for calculating the percentage of oxygen is incorrect as the candidate has divided by 40 rather than 50.

Question 1 (c)

Generally well answered with half the candidates scoring the 2 marks available.

In many responses candidates appreciated that the change resulted from the increased levels of oxygen, scoring the first mark, but then through incorrect terminology did not score the second one.

(c) The Earth's earliest rocks contained iron sulfide and no iron oxide.
Later the rocks contained iron oxide as well as iron sulfide.

Explain what happened to allow this change to occur.

(2)

An increase in the amount of oxygen ~~it~~ in the air allowed for the (natural) formation of iron oxide. ~~This~~ Oxygen in the air increased due to the growth of plants (consuming carbondioxide, expelling oxygen).

ResultsPlus
Examiner Comments

This was a typical response scoring 1 mark only.

The correct reference to 'an increase in the amount of oxygen' in line one is worth 1 mark and likewise, the same marking point could also be awarded for lines three and four of this response. However, the reference to 'the formation of iron oxide' is not sufficient to score any further credit.

(c) The Earth's earliest rocks contained iron sulfide and no iron oxide. Later the rocks contained iron oxide as well as iron sulfide.

Explain what happened to allow this change to occur.

(2)

Oxygen wasn't very present in Earth's early atmosphere, but as plants began to evolve and started to photosynthesise, they released oxygen gas. This started to react with iron, leading to rocks containing iron oxide as well as iron sulfide.

(Total for Question 1 = 7 marks)

ResultsPlus
Examiner Comments

This is a good response which scored 2 marks.

There are correct references to both photosynthesis releasing oxygen and the reaction of iron with oxygen.

Question 2 (a) (i)

The vast majority of candidates scored the 1 mark available by giving the answer of 35, but some thought they could simply use the value given on the periodic table, but this is the **relative atomic mass** of 35.5 and not the **mass number** of that particular atom. A few candidates chose to add together the numbers of all sub-atomic particles, but this was rarely seen.

Question 2 (a) (ii)

The vast majority of candidates scored with the correct answer of 2.8.7, but in a very few cases, either had an extra shell of electrons or a different set of numbers that added up to 17.

Question 2 (b)

Generally very well answered with most candidates able to score 1 or 2 of the 2 marks available.

The complete result of the test for chlorine in that 'the indicator paper would turn red first then be bleached' was given by just less than half of the candidates.

However, many responses scored just 1 mark for either stating 'the indicator paper turning red' or 'being bleached' only. Those who had the order the wrong way round were not credited with the marks.

(b) Describe what you would **see** if damp, blue litmus paper is placed into chlorine gas.

(2)

The damp blue litmus paper will turn red then eventually bleach at the presence of chlorine gas.

ResultsPlus
Examiner Comments

A typical correct response scoring 2 marks.

There are correct references to the damp blue litmus turning red and then being bleached.

(b) Describe what you would **see** if damp, blue litmus paper is placed into chlorine gas.

(2)

The damp blue litmus paper would change into a pink colour and then finally a red colour.

ResultsPlus

Examiner Comments

A typical response which scored 1 mark only.

The correct reference to damp blue litmus turning red scored the first marking point. The initial reference to 'pink' on its own would also have scored this point. However, there is no mention of 'bleaching', so this limited the score to 1 mark.

ResultsPlus

Examiner Tip

The tests for gases mentioned in the specification, such as the test for chlorine, are frequently asked for in examination - learn the tests and the observations for these tests.

(b) Describe what you would **see** if damp, blue litmus paper is placed into chlorine gas.

(2)

The Colour would change from ~~t~~ blue to a more red - green colour

ResultsPlus
Examiner Comments

This response was not creditworthy.

The colour change to 'red-green' cannot be accepted.

ResultsPlus
Examiner Tip

Learn the colour changes for the indicators in the specification and the test for chlorine (and the correct observations for this test).

Question 2 (c) (i)

Generally well answered with most candidates able to score at least 1 of the 2 marks available.

This question has been asked in this format for many years, but it was surprising to see how few candidates scored the two marks. The majority scored just 1 mark for a description involving the ‘sharing of an electron or the sharing of electrons’.

Common errors, omissions, misconceptions:

In some responses candidates incorrectly described a covalent bond as being between ‘two or more’ elements or atoms or molecules.

(c) Chlorine exists as diatomic molecules.

In a molecule, two chlorine atoms are joined by a covalent bond.

(i) Describe what is meant by a **covalent bond**.

(2)

A covalent bond is ~~shar~~ where two atoms share a pair of electrons, mainly a gaseous atom and a metal.

ResultsPlus
Examiner Comments

This response scored 2 marks.

The correct reference to 'atoms share a pair of electrons' scores both marking points.

(c) Chlorine exists as diatomic molecules.

In a molecule, two chlorine atoms are joined by a covalent bond.

(i) Describe what is meant by a **covalent bond**.

(2)

A covalent bond is the sharing of electrons between two or more non-metals to get a full outer shell.

ResultsPlus
Examiner Comments

This answer was typical of a 1 mark response.

The reference to' sharing of electrons' is creditworthy. However, there is no reference in this response to the number of electrons shared, namely two.

ResultsPlus
Examiner Tip

Learn the definitions for the different types of bonding in the specification: covalent, ionic and metallic bonding.

Question 2 (c) (ii)

Most candidates were able to score only 1 of the 2 marks available by stating that chlorine has a low boiling point as the explanation for chlorine being a gas at room temperature.

Explanations in terms of intermolecular forces being weak were rarely seen; often answers were given in terms of 'bonds' which consequently limited the mark candidates could score.

Common errors, omissions, misconceptions:

Some candidates incorrectly referred to 'a low melting point' rather than the boiling point and consequently did not score here. In some responses, the main misconception was that candidates incorrectly discussed the breaking of weak covalent bonds.

It is important for centres to note that the term '**intermolecular force**' is that used in this specification and that the term intermolecular bond could be confused with a dative covalent bond, so is not acceptable.

(ii) Explain why chlorine is a gas, rather than a liquid, at room temperature.

(2)

The bonds between the chlorine particles break easily, so it doesn't require much energy, such as heat energy, to break them.

ResultsPlus
Examiner Comments

This response is not creditworthy.

The breaking of any type of bond does not score and there is no mention in this response of chlorine having a low boiling point.

ResultsPlus
Examiner Tip

Make sure that you can explain the low boiling points (and melting points) of typical covalent, simple molecular compounds, such as chlorine, by reference to weak intermolecular **forces**.

(ii) Explain why chlorine is a gas, rather than a liquid, at room temperature.

(2)

Chlorine is a gas at room temperature as ~~they~~ it has weak intermolecular forces which are overcome however the covalent bonds between chlorine are not overcome. It is a covalent substance so it has a low boiling point, due to it's weak intermolecular forces.

ResultsPlus
Examiner Comments

A typical example of fully correct response which scored 2 marks, covering all three possible marking points.

The candidate has mentioned weak intermolecular forces and also the fact that chlorine has a low boiling point.

Question 2 (d)

Generally very well answered with most candidates able to score the 1 mark available with answers expressed in variety of ways.

A common error seen in some responses was for candidates to correctly discuss the solution being 'acidic', but to then incorrectly ascribe the acidity to chlorine or chloride ions. Consequently this did not score. Surprisingly, in a very few cases, candidates thought the solution was alkaline.

(d) When the gas hydrogen chloride, HCl, is dissolved in water, a solution forms.
Blue litmus paper dipped in this solution turns red.

State why the litmus paper turns red.

(1)

The presence of hydrogen and chloride ~~indi~~ is indicated when the blue litmus paper turns red.

ResultsPlus
Examiner Comments

This response was not creditworthy.

There is no mention of 'acidic' or 'hydrogen ions'. 'Chloride' (ions) is also an incorrect reason for the observation.

(d) When the gas hydrogen chloride, HCl, is dissolved in water, a solution forms. Blue litmus paper dipped in this solution turns red.

State why the litmus paper turns red.

(1)

Hydrochloric acid forms and litmus turns red in acidic conditions.

ResultsPlus
Examiner Comments

A typically seen correct response for 1 mark.

The correct reference to 'hydrochloric acid forms' and/or 'acidic' are creditworthy.

Question 3 (a)

Generally very well answered with most candidates able to score all 3 marks available.

This was a well-performed calculation. It would seem that many candidates are well-drilled in evaluating an empirical formula, with working clearly set out in most of the responses seen.

Common errors, omissions, misconceptions:

There were still a significant number of candidates who obtained the 2:1 ratio and then were unable to write an empirical formula, restricting the score to 2 marks. There were the usual (typically seen in previous examination series) errors of getting the initial fractions upside down and using 32 for the mass of oxygen rather than 16. However, many candidates carried on correctly and earned marks from the allowance of an error carried forward. Some candidates used S as the symbol for sodium when writing the empirical formula.

3 Lithium, sodium and potassium are reactive metals in group 1 of the periodic table.

(a) Sodium metal tarnishes in air to form a layer of sodium oxide on its surface.
0.92 g of sodium combined with 0.32 g of oxygen in this oxide.

Calculate the empirical formula of this sodium oxide.
(relative atomic masses: O = 16, Na = 23)

You must show your working.

(3)

	O		Na	
RAM	16	:	23	
Mass	0·92	:	0·32	Sodium oxide NaO?
	0·0575*	:	0·014 ÷ 0·014	
=	4	: =	1	

* ÷ 0·014

empirical formula of sodium oxide = NaO_4

ResultsPlus
Examiner Comments

This response scored 2 of the 3 marks available.

There is only one error in this calculation, namely the masses of Na and O have been transposed. The error can be carried forward which allows 2 marks to be awarded.

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Calculate the empirical formula of this sodium oxide.
(relative atomic masses: O = 16, Na = 23)

You must show your working.

(3)

Sodium	Oxygen
0.92g	0.32g
0.92/23 = 0.04	0.32/16 = 0.02
$\frac{0.04}{0.02} = 2$	$\frac{0.02}{0.02} = 1$
= Na_2	O

empirical formula of sodium oxide = Na_2O

ResultsPlus
Examiner Comments

A typically fully correct response which scored 3 marks.

All key steps in the working have been shown.

Question 3 (b)

Generally very well answered with most candidates able to score 2 or 3 of the 3 marks available for balancing the equation and giving the correct state symbols.

Common errors in responses were:

Writing numbers instead of state symbols or candidates thinking that the formula needed to be completed, *e.g.* Na(OH) where OH was written in the space for the state symbol or incorrectly giving (aq) as the state symbol for water.

(b) Sodium reacts with water to form sodium hydroxide solution and hydrogen.

Complete the balancing of the equation for this reaction and add the state symbols for each substance.

(3)

..............Na(...s...) + $2H_2O$(...l...) → .... NaOH(...aq...) + H_2(...g...)

ResultsPlus
Examiner Comments

This response scored 1 mark only.

The candidate has not attempted to balance the equation. The mark awarded is for the correct state symbols which are marked independently of the balancing.

(b) Sodium reacts with water to form sodium hydroxide solution and hydrogen.

Complete the balancing of the equation for this reaction and add the state symbols for each substance.

(3)

$$2\ Na(OH\ldots) + 2H_2O(\ldots) \rightarrow 2\ NaOH(\ldots) + H_2(\ldots)$$

ResultsPlus
Examiner Comments

This response scored 2 of the 3 marks available.

The equation is correctly balanced and scores 1 mark for 2 Na and 1 mark for 2 NaOH.
Clearly the mark for the state symbols is not scored. This is marked independently of the balancing. Although the OH in brackets is clearly changing the formula of Na to NaOH, this would not affect the awarding of the first two marks for balancing the equation.

Question 3 (d)

Generally well answered with most candidates able to score 1 or 2 of the 2 marks available.

A large majority of candidates managed to score the first marking point in one of the many ways possible, 'more shells' being the most commonly seen. A few gave correct electron configurations which was acceptable for the first marking point. The second mark was less frequently scored.

Common errors, omissions, misconceptions:

Many candidates referred to simply losing electrons rather than the vital '**outer**' electron. Some candidates simply asserted that electrons being further from the nucleus meant that the element was more reactive. There were fewer references to multiple outer shells than seen by examiners in equivalent questions in previous series, nor were there many references to intermolecular forces between electron and nucleus.

(d) Explain, in terms of electronic configurations, the increase in reactivity from lithium to sodium to potassium.

(2)

there are more outer shells as electrons as you travel from lithium to sodium to potassium. This makes potassium more reactive than the others as it is more willing to take other electrons

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Examiner Comments

This is a typical example of a response which did not score.

The incorrect reference to 'more outer shells' is rejected for the first marking point. The second marking point is not scored since there is no mention of the ease of loss of outer electrons.

Other points to note regarding this response: the number of outer shells does not increase and potassium does not take electrons.

ResultsPlus
Examiner Tip

Remember to discuss the **outer** electron or outer electron shell - avoid the use of the incorrect 'more outer electron shells'.

Learn the explanations, in terms of electron configurations, for the trend in reactivity for the main groups asked for in the specification, namely Group 1 and Group 7.

(d) Explain, in terms of electronic configurations, the increase in reactivity from lithium to sodium to potassium.

(2)

Potassium is the most reactive as it has the largest atomic radius so it's 1 outer electron has a lower force of attraction to the positive nucleus so is more easily lost in reactions compared to litium which has the shortest atomic radius of the three so its outer electron is more strongly attracted to the nucleus and is less easily lost to react.

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Examiner Comments

This response scored 2 marks - a very good response.

All the marking points have been adequately covered. The correct references to potassium having the largest atomic radius and the correct idea of a decreased force of attraction between the outer electron and nucleus are clearly mentioned. The correct idea of the outer electron being more easily lost is also mentioned.

Question 4 (a) (i)

Generally well answered with most candidates able to score the 1 mark available for mentioning that 'energy is lost'. The word 'dissipate' was frequently seen by examiners.

Incorrect responses included: experimental error, too much water, other side-reactions might occur, did not burn for long enough, the value is theoretical is therefore never achieved (possibly thinking of yields). Others said that ethanol did not burn fully which was excluded by the question.

4 Ethanol can be used as a liquid fuel.

A student investigates how much heat energy is released when a known mass of ethanol is burned.

The apparatus is set up as shown in Figure 3.

A known volume of water is placed in a metal can.
The temperature of the water is measured.
The ethanol is ignited and placed under the beaker so that the flame is touching the beaker.
The water is heated by the flame.
The flame is extinguished.
The final temperature of the water is measured.

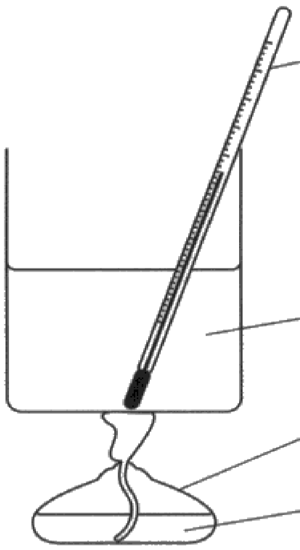

Figure 3

(a) The theoretical temperature rise for burning a given mass of ethanol is 82.4 °C.

In the experiment the actual temperature rise for burning this mass of ethanol was only 34.8 °C.
One reason why the temperature rise is less than expected is that the ethanol does not burn completely.

(i) Give a reason why, even if the ethanol burns completely, the actual temperature rise is much less than the theoretical value.

(1)

Because some of the ~~ethanol~~ heat energy is released into the surrounding.

ResultsPlus
Examiner Comments

A typical correct response scoring 1 mark.

'Heat energy' is fine and 'released into the surrounding' describes it being lost.

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The temperature of the water is measured.
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The flame is extinguished.
The final temperature of the water is measured.

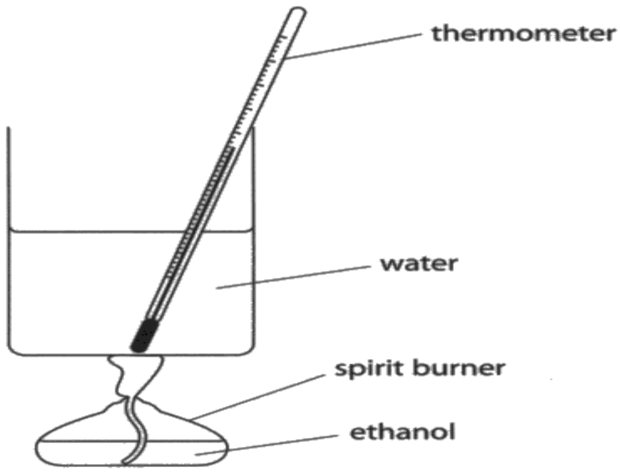

Figure 3

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One reason why the temperature rise is less than expected is that the ethanol does not burn completely.

(i) Give a reason why, even if the ethanol burns completely, the actual temperature rise is much less than the theoretical value.

(1)

Some of the ethanol gas might've escaped into the air.

ResultsPlus
Examiner Comments

A typical incorrect response.

The response incorrectly refers to 'ethanol gas' escaping. This is the wrong thing that has 'escaped' - it is heat/energy that escapes.

Question 4 (a) (ii)

Generally well answered with about half the responses able to score the 2 marks available, with most candidates recognising the need for a lid or another form of insulation and the effect that would have in reducing heat loss.

Incorrect responses included:

Proposing the use of a 'closed system' without indicating how this may be accomplished practically. Some wanted to move the burner closer although the diagram showed it very close already. Some missed the point completely and were proposing purer ethanol or better weighing of the fuel or a whole range of other spurious changes.

(ii) Explain how the method described above could be improved to give a temperature rise closer to the theoretical value.

(2)

The person should put a lid on the beaker and insulate the sides to prevent energy being lost to the surroundings giving a closer tempreture increase to the theoretical.

ResultsPlus
Examiner Comments

A typical example of the responses which scored 2 marks.

This gains both the first and second marking points for adding a 'lid' and for the idea of the prevention of energy loss.

(ii) Explain how the method described above could be improved to give a temperature rise closer to the theoretical value.

(2)

~~Using a bunsen~~ Use a smaller amount of water and increase the spirit burner size - this would give more heat to a smaller volume - it would be hotter.

ResultsPlus
Examiner Comments

This response was not creditworthy.

The changes suggested will change the theoretical value as there is less water being heated, so does not answer the question.

Question 4 (a) (iii)

Generally extremely well answered with most responses scoring the 2 marks available.

Incorrect responses included:

The use of an incorrect temperature change, particularly 82.4, 82.4 minus 34.8, and 34.8 minus an assumed room temperature often 20. This limited the score to 1 mark for an error carried forward.

(iii) The amount of heat energy used to raise the temperature of the water by 34.8 °C can be calculated using

heat energy = 210 × temperature rise

Calculate the amount of heat energy used.

(2)

210 x 34·8 = 7308

heat energy = 7308 (energy units)

ResultsPlus
Examiner Comments

A typical example of a correct response, scoring 2 marks.

The correct numerical answer, namely 7308 (energy units), is credited with full marks.

(iii) The amount of heat energy used to raise the temperature of the water by 34.8 °C can be calculated using

heat energy = 210 × temperature rise

Calculate the amount of heat energy used.

(2)

34.8 - 82.4 = -47.6 hE = 210 x -47.6
= -9996

heat energy = -9996 (energy units)

ResultsPlus
Examiner Comments

A typical example of a response only scoring 1 of the 2 marks available, with an error carried forward.

The final answer is not 7308. However, there is 210 multiplied by a number which has then been correctly evaluated. The sign on the answer can be ignored.

Question 4 (b)

This was poorly answered overall, with most candidates scoring just 1, sometimes 2, of the 3 marks available.

This should have been a straightforward question since all that was required is to state the standard features of a homologous series.The ‘same functional group/identification of the ‘-OH" and ‘same general formula’ were the most common correct answers seen by the examining team.

Common errors, omissions, misconceptions:

There were many references to the compounds being hydrocarbons in one sentence and then saying that all the molecules contained just carbon, hydrogen and oxygen. A number of candidates talked about the 'same general formula' and then spoilt this by giving an incorrect general formula. Many talked vaguely about the same or similar properties or incorrectly about same physical properties.

(b) Propanol and butanol are both members of the same homologous series as ethanol.

propanol alcohol butanol

Propanol and butanol can also be burned in the apparatus shown in Figure 3.

Give **three** reasons why ethanol, propanol and butanol are members of the same homologous series.

(3)

reason 1 They are alcohols. ~~-OH~~

reason 2 ~~Repeating~~ always have -OH unit.

reason 3 Alkanes, saturated, only single bonds.

ResultsPlus
Examiner Comments

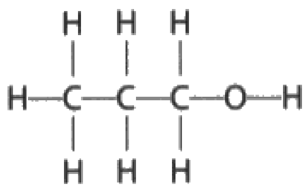
This response scored only 1 of the 3 available marks.

Although correctly identified as alcohols this is not a marking point and cannot score. They are not alkanes, so only reason two, namely that they all have -OH, scores a mark.

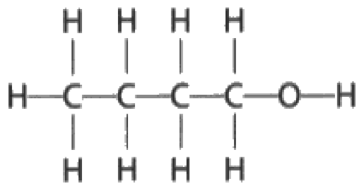
ResultsPlus
Examiner Tip

Learn the definition of a homologous series. This has been frequently asked for in the previous examination series and also a requirement on this new specification.

(b) Propanol and butanol are both members of the same homologous series as ethanol.



propanol



butanol

Propanol and butanol can also be burned in the apparatus shown in Figure 3.

Give **three** reasons why ethanol, propanol and butanol are members of the same homologous series.

(3)

reason 1 they are all alcohols - used for medical drugs, cosmetics, varnishes, etc

reason 2 have the functional group OH which means they react similarly

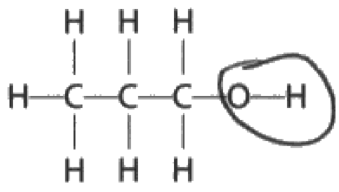
reason 3 the alkanes - follow the general formula of C_nH_{2n+2} .

ResultsPlus
Examiner Comments

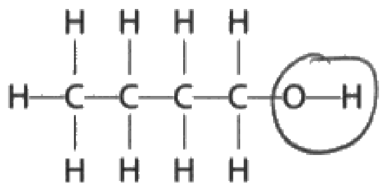
This response scored 2 of the 3 marks available.

The first reason given in the response is ignored on the mark scheme. The second reason line has two correct points, namely same 'functional group , -OH', and 'react similarly'. The third reason line is incorrect. Hence the response scores 2 marks for two correct reasons (on the same line).

(b) Propanol and butanol are both members of the same homologous series as ethanol.



propanol



butanol

Propanol and butanol can also be burned in the apparatus shown in Figure 3.

Give **three** reasons why ethanol, propanol and butanol are members of the same homologous series.

(3)

reason 1 They all have an OH functional group

reason 2 They all follow the general formula $C_nH_{2n+1}OH$

reason 3 They all react with carboxalic acids to form esters

ResultsPlus
Examiner Comments

A good example of a rarely seen fully correct response.

All three reasons given are creditworthy.

Question 4 (c) (i)

Generally well answered with most candidates able to score 1 or 2 of the 2 marks available.

Common errors, omissions, misconceptions:

In some cases candidates attempted balanced equations, many of which were correct, even though the question simply required a word equation. Some candidates incorrectly opted for the reaction leading to carbon dioxide and water. Others started with propanol and went on to produce ethanoic acid. Others incorrectly wrote 'air' as a reactant species.

(c) Ethanol can oxidise when exposed to air to produce ethanoic acid and water. Propanol can also oxidise in a similar reaction when it is exposed to air.

(i) Write the word equation for the reaction when **propanol** oxidises when it is exposed to air.

(2)

propanol + oxygen → propanoate + hydrogen

ResultsPlus
Examiner Comments

This response was not creditworthy.

There are two incorrect substances, namely 'propanoate' and 'hydrogen' shown as products on the right hand side of this equation.

(c) Ethanol can oxidise when exposed to air to produce ethanoic acid and water. Propanol can also oxidise in a similar reaction when it is exposed to air.

(i) Write the word equation for the reaction when **propanol** oxidises when it is exposed to air.

(2)

propanol + air → propanoic acid + water

ResultsPlus
Examiner Comments

This response only scored 1 of the 2 marks available.

There are three correct substances. 'Air' is not acceptable.

ResultsPlus
Examiner Tip

In word equations involving oxidation, 'air' is not a correct species.

Question 5 (a)

Generally extremely well answered with most responses scoring the 1 mark available for correctly identifying that the reason why the ceramic is a more suitable material is that 'it (the ceramic) has no reaction with water'.

In the very few responses that did not score, other irrelevant properties were selected from the table of data supplied.

5 (a) Figure 4 shows information about a ceramic and a metal.

	ceramic	metal
flexibility	low	high
hardness	medium	low
reaction with water	no reaction	very slow reaction
density	medium	high

Figure 4

The ceramic, rather than the metal, is a more suitable material for washbasins.

Give a reason for this, using a property from Figure 4.

(1)

it has a lower density and so will not be heavy to hold.

ResultsPlus
Examiner Comments

This was a typical example of a rarely seen incorrect response.

Although the candidate has referred to the table and a correct statement/property from the table, the response does not explain why the ceramic is used in wash basins in reference to water.

Question 5 (b)

Generally poorly answered, especially since the skill of deducing the monomer from a polymer and propene/polypropene are specifically mentioned in the specification. Most candidates only scored 1 of the 2 marks available.

Common errors, omissions, misconceptions:

Too many candidates missed the instruction clearly in the question to show all covalent bonds and abbreviated the –CH_3 group, restricting this to 1 mark. There were a number of responses which simply did not have a three carbon chain while others featured penta- and tri-valent carbons. Some candidates, mostly unsuccessfully, tried a dot and cross diagram.

(b) Poly(propene) is an example of a polymer.

The structure of a poly(propene) molecule is shown in Figure 5.

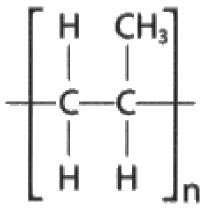
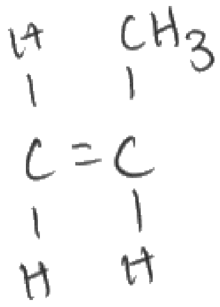


Figure 5

This polymer is made from a monomer.

Draw the structure of the monomer molecule showing all covalent bonds.

(2)



Propene

ResultsPlus
Examiner Comments

A typical example of a response commonly seen by the examining team which only scored 1 mark.

The first marking point is awarded for one C=C bond in a three consecutive carbon atom molecule. However, the second marking point is not awarded as methyl group not been drawn fully displayed, showing all the C-H covalent bonds.

ResultsPlus
Examiner Tip

Read the question carefully when drawing the structure of organic molecules - often requiring all covalent bonds to be drawn.

(b) Poly(propene) is an example of a polymer.

The structure of a poly(propene) molecule is shown in Figure 5.

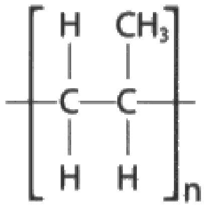
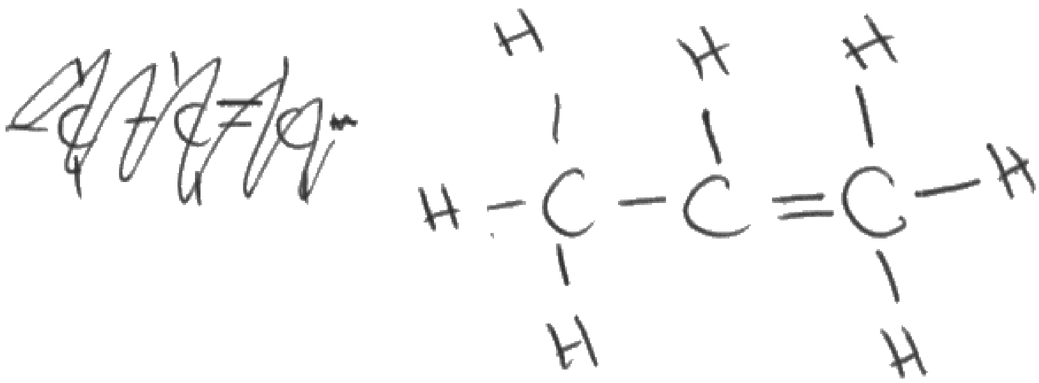


Figure 5

This polymer is made from a monomer.

Draw the structure of the monomer molecule showing all covalent bonds.

(2)



ResultsPlus
Examiner Comments

This response only scored 1 of the 2 marks available.

The first marking point is awarded for one C=C bond in a three consecutive carbon atom molecule. However, the second marking point is not awarded since there are too many hydrogen atoms bonded to the carbon atom at the end of the molecule, effectively a penta-valent carbon.

ResultsPlus
Examiner Tip

When drawing the structures of hydrocarbons, take care to ensure that the carbon atoms should be bonded by no more than four covalent bonds.

Question 5 (c)

Generally well answered with the majority of responses able to score 1 or 2 of the 2 available marks.

Common errors, omissions, misconceptions:

Many candidates knew about the poor conductivity of PVC but relatively few related its use to the prevention of shock *etc*. Others knew about flexibility but rarely related that to unlikelihood of breaking when the cable is bent. Few candidates picked up on the third option in the mark scheme, relating to the inertness of PVC and most who did had already scored from one of the other points.

(c) A layer of poly(chloroethene) (PVC) is used to surround the copper in electrical cables.

Explain why poly(chloroethene) is a suitable material for this purpose.

(2)

as it adds a protective layer over electrical cables and prevents anything from contaminating it.

ResultsPlus
Examiner Comments

This response was not creditworthy.

Neither has a specific property been mentioned nor has a reason been given as to why PVC is used.

(c) A layer of poly(chloroethene) (PVC) is used to surround the copper in electrical cables.

Explain why poly(chloroethene) is a suitable material for this purpose.

(2)

PVC is flexible and a good ~~conductor~~ insulator of electricity therefore is suitable to cover copper cables to help the copper electrical conductivity. PVC is also waterproof.

ResultsPlus
Examiner Comments

This response was typical of many of the responses scoring 1 mark only.

There are lots of correct properties of PVC listed in this response, namely 'flexible', 'good insulator of electricity' and 'waterproof' but none of these have been explained, restricting the score to 1 mark.

(c) A layer of poly(chloroethene) (PVC) is used to surround the copper in electrical cables.

Explain why poly(chloroethene) is a suitable material for this purpose.

(2)

It is an electrical ~~ts~~ insulator, so prevents people ~~com~~ getting electrocuted when they touch the wire.

ResultsPlus
Examiner Comments

This is a typical example of the most commonly seen property and linked reason which scored the 2 marks available.

The property 'electrical insulator' and linked reason 'prevents people getting electrocuted' both score the 2 marks.

ResultsPlus
Examiner Tip

Remember to both identify a property and to give a reason for this choice when answering questions linking uses and properties of a particular material.

Question 5 (e) (i)

Whilst there were a few excellent responses, this question was generally very poorly answered with very few responses scoring either of the 2 marks available.

Common errors, omissions, misconceptions:

Many candidates were trying to get carbon-carbon double bonds into their structures. Some managed to show a –COOH group and a –OH group but only on one side of the proposed molecules. In many cases, the end bonds were simply left hanging.

(e) The repeating unit in a polyester molecule is shown in Figure 6.

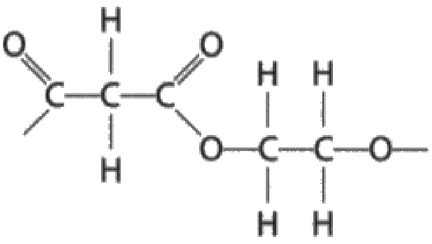
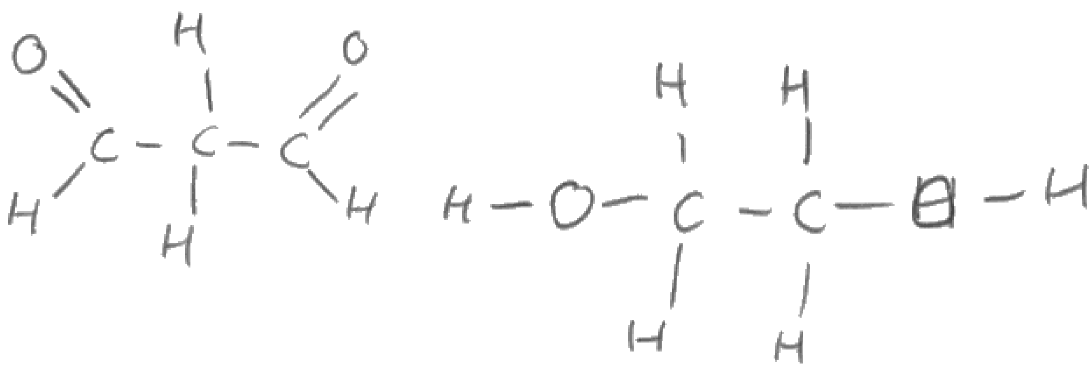


Figure 6

(i) This polymer is made from two different monomers.

Draw a molecule of each monomer showing all covalent bonds.

(2)



ResultsPlus
Examiner Comments

This response scored 1 mark only.

The structure of the diol shown on the right hand side of the candidate's response is correct and scores the second marking point. However, the other molecule is a dial, not a di-carboxylic acid and so the first marking point does not score.

ResultsPlus
Examiner Tip

Make sure that you can draw the monomers given the repeating unit in a polyester or vice versa.

(e) The repeating unit in a polyester molecule is shown in Figure 6.

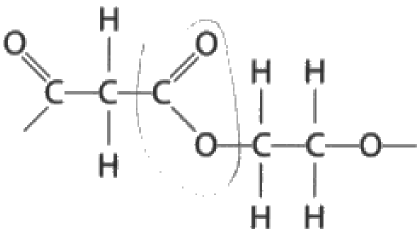
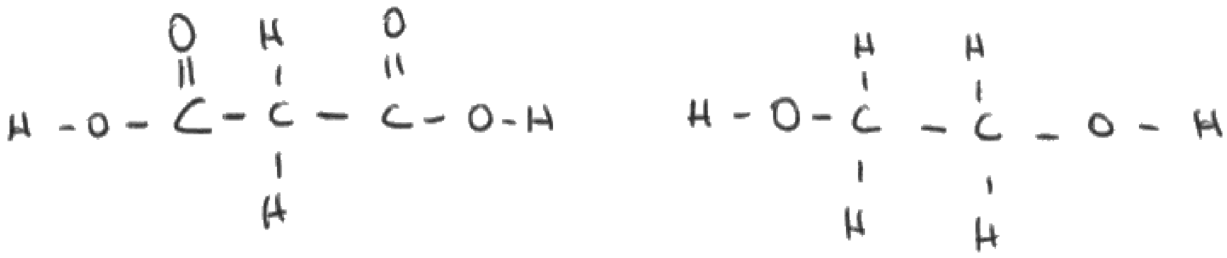


Figure 6

(i) This polymer is made from two different monomers.

Draw a molecule of each monomer showing all covalent bonds.

(2)

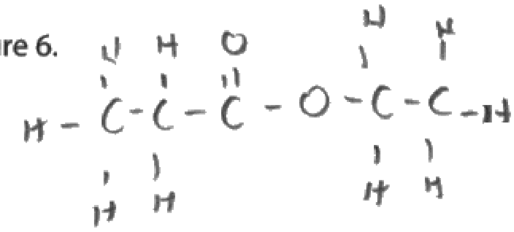


ResultsPlus
Examiner Comments

A good example of a rarely seen fully correct response.

Both the structures of the di-carboxylic acid and diol have been correctly drawn, so this response scores 2 marks.

(e) The repeating unit in a polyester molecule is shown in Figure 6.



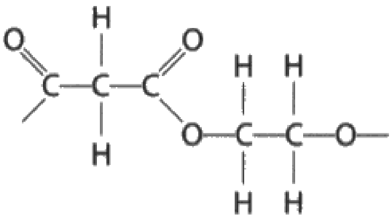
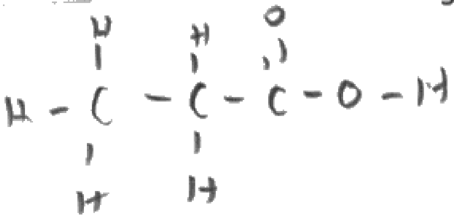


Figure 6

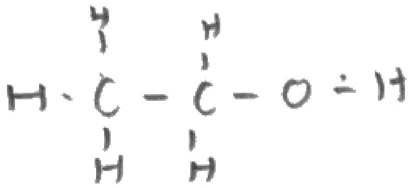
(i) This polymer is made from two different monomers.

Draw a molecule of each monomer showing all covalent bonds.

(2)



Rnotonic acid
C_2H_5COOH



Ethanol
C_2H_5OH

ResultsPlus
Examiner Comments

This response did not score.

Unfortunately, although the candidate has recognised the correct functional groups in the monomers, namely that the alcohol and carboxylic acid are used to form an ester, these have only been shown on one side of the proposed molecules. Consequently, this cannot score.

Question 5 (e) (ii)

Generally not well answered with under half of the candidates able to identify 'water' as the small molecule formed in the condensation reaction.

Question 6 (b) (ii)

Generally very well answered, with the majority of responses scoring the 2 marks available for a standard definition of a hydrocarbon.

This was another question that was similar to those set on the previous specification.

Common errors, omissions, misconceptions:

Although many candidates made the point that alkanes contain only hydrogen and carbon, some spoilt their answer answers by incorrectly using the terms 'mixture of hydrogen and carbon' or 'hydrogen molecules and/or carbon molecules'.

(ii) Explain why alkanes are described as hydrocarbons.

(2)

Alkanes are described as hydrocarbons as the have a single bonds between hydrogen and carbon atoms, where it is a saturated molecule, formula of C_nH_{2n+2}

ResultsPlus
Examiner Comments

This response scored 1 mark only.

The correct reference to 'carbon and hydrogen atoms' is credited in the second line of this response. The fact that it mentions that these are bonded together with single bonds is correct in alkanes and can be ignored. The second marking point is not scored since the response does not mention 'only' which is pertinent to the fully correct definition of a hydrocarbon. Stating the general formula of an alkane is insufficient.

ResultsPlus
Examiner Tip

The definitions of a hydrocarbon, saturated and unsaturated are in the specification and you should be able to recall them.

(ii) Explain why alkanes are described as hydrocarbons.

(2)

An alkane is described as a hydrocarbon as it only consists of molecules that are hydrogen and carbon.

ResultsPlus
Examiner Comments

This response was not creditworthy.

Although both hydrogen and carbon have been referred to, the use of 'molecules that are hydrogen and carbon' is not correct, so the response did not score.

ResultsPlus
Examiner Tip

When defining a hydrocarbon the use of 'carbon molecules' and/or 'hydrogen molecules' is incorrect.

Question 6 (c)

Most candidates were able to score only 1 of the 2 marks available by describing the pattern in terms of the greater the number of carbon atoms in a molecule of alkane, the higher the boiling point.

As was seen in a previous question, 2(c)(ii), explanations in terms of increased intermolecular forces were rarely seen; often answers were given in terms of ‘bonds’ which limited the mark candidates could score to 1 mark.

Common errors, omissions, misconceptions:

In some responses, the main misconception was that candidates incorrectly discussed the breaking of alkane molecules or covalent bonds.

(c) Figure 8 shows a graph of the boiling points of some alkanes against the number of carbon atoms in one molecule of each alkane.

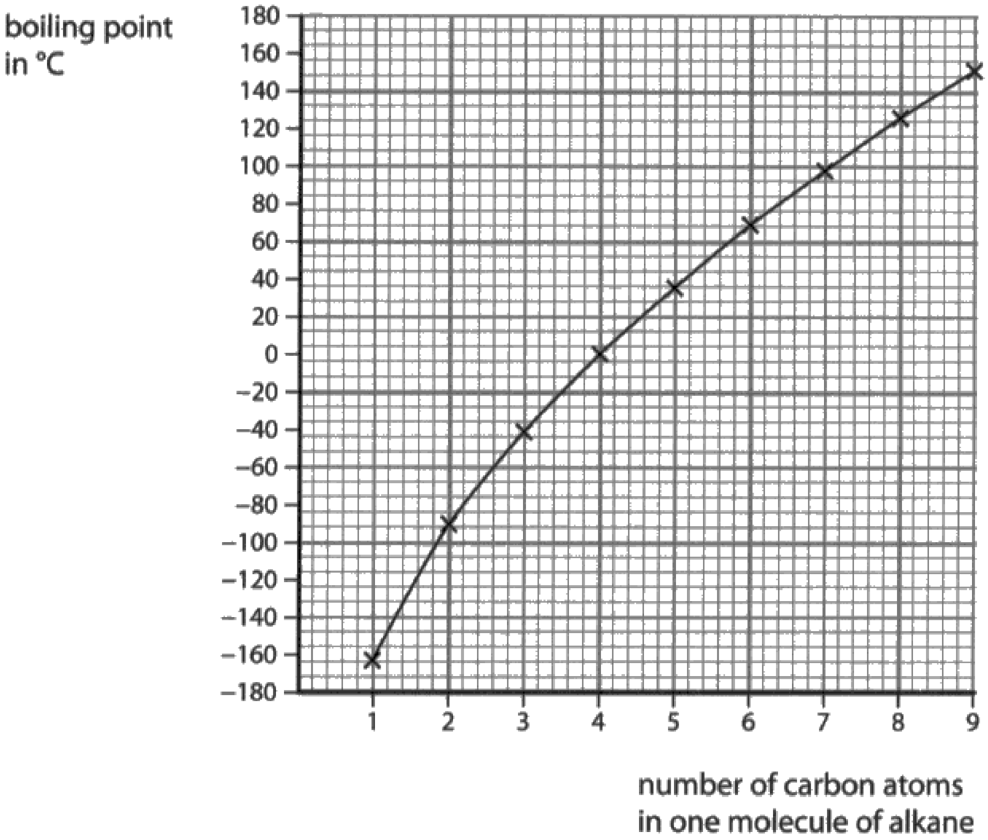


Figure 8

Explain the pattern shown by this graph.

(2)

The graph ~~e~~ shows that the more carbon atoms a hydrocarbon has the higher the melting point becomes. This is shown by the gradual increase with the graph.

ResultsPlus
Examiner Comments

This response was not creditworthy.

Although the response appears to have the right idea regarding the trend in the data for the first marking point, unfortunately the response is actually talking about melting point, rather than boiling point, so does not score.
The other marking points have not been scored since there is no mention of intermolecular forces.

(c) Figure 8 shows a graph of the boiling points of some alkanes against the number of carbon atoms in one molecule of each alkane.

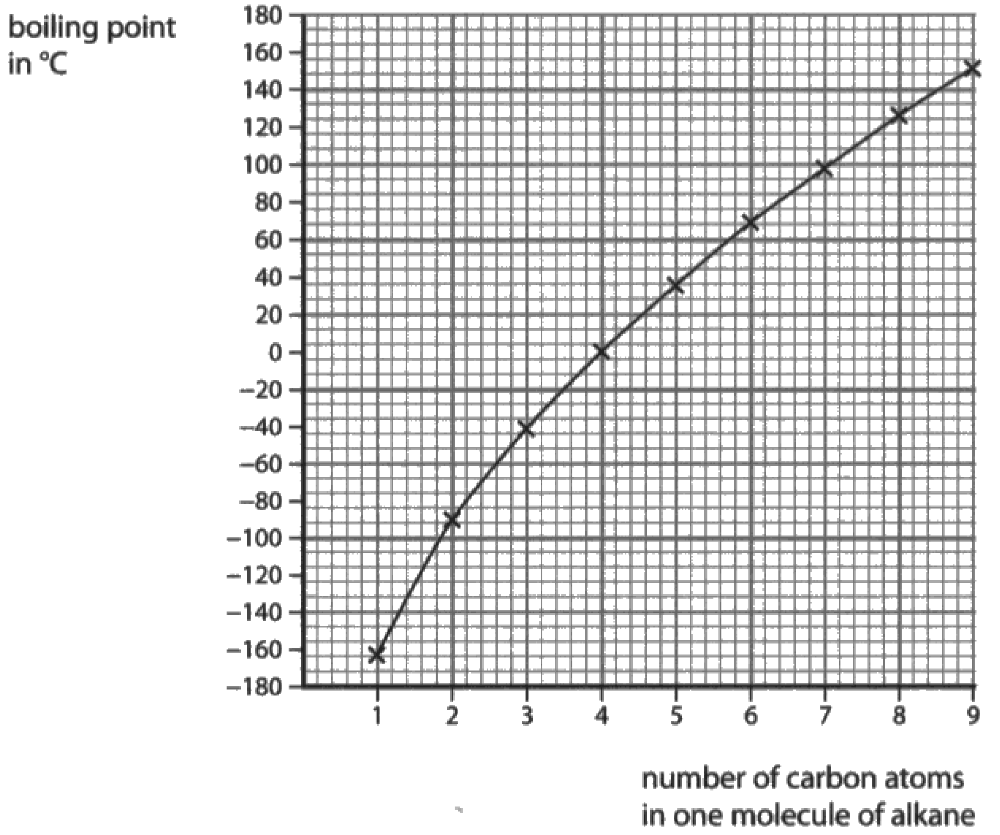


Figure 8

Explain the pattern shown by this graph.

(2)

Overall, as the number of carbon atoms in one molecule of alkane increases the boiling point increases. This is because, as the chain of carbon atoms increase, it means more energy is required to break the more and stronger intermolecular forces between the carbon atom. Hence, boiling point increases.

ResultsPlus
Examiner Comments

This response scored 1 mark and is typical of the many responses seen by examiners scoring 1 mark only.

The response has the right idea regarding the trend in the data, namely that of boiling point increasing with number of carbon atoms, so the first marking point is awarded.
The second marking point would have been scored for 'stronger intermolecular forces' but this is contradicted by the response mentioning that this force is between atoms, so cannot be awarded.

ResultsPlus
Examiner Tip

When explaining the trend in boiling points of simple covalent molecules, ensure that you refer to forces between molecules.

(c) Figure 8 shows a graph of the boiling points of some alkanes against the number of carbon atoms in one molecule of each alkane.

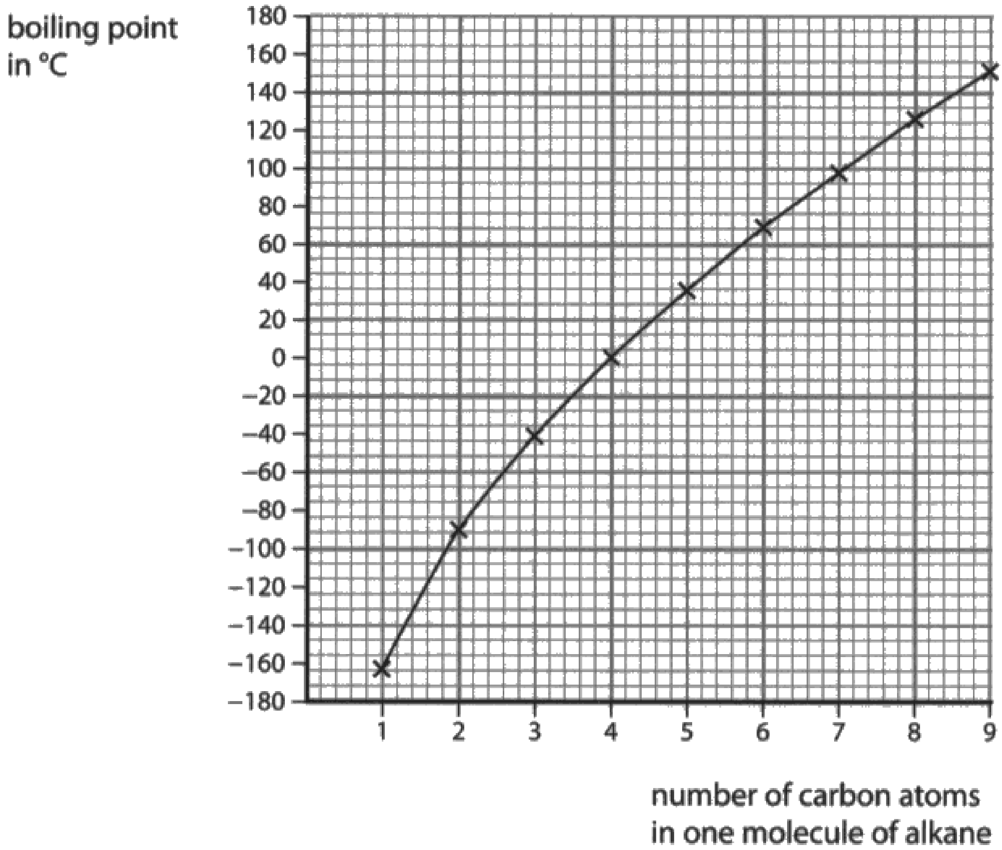


Figure 8

Explain the pattern shown by this graph.

(2)

The more carbon atoms in one molecule of alkane the higher the boiling point is. This is because the more atoms there are, the harder it is to break the strong intermolecular forces. If there were less atoms it would be easier to break as there are fewer and will therefore have a lower boiling point

ResultsPlus

Examiner Comments

An example of a rarely seen and fully correct response which scored 2 marks.

All the possible available marking points are awarded.

Question 6 (d) (i)

Generally well answered on the whole, with the majority of the candidates identifying ‘fuel oil’ as the fraction that was most likely to be cracked. Nearly all the incorrect responses, indicating a misunderstanding of the question, referred to petrol.

Question 6 (d) (ii)

Most candidates were able to score 2 of the 3 marks available.

The endothermic reaction profile was known only to about half the candidates. Most candidates managed to label the positions of reactants and products correctly. Only a small number could show the activation energy correctly on an endothermic reaction profile to score all the marks available.

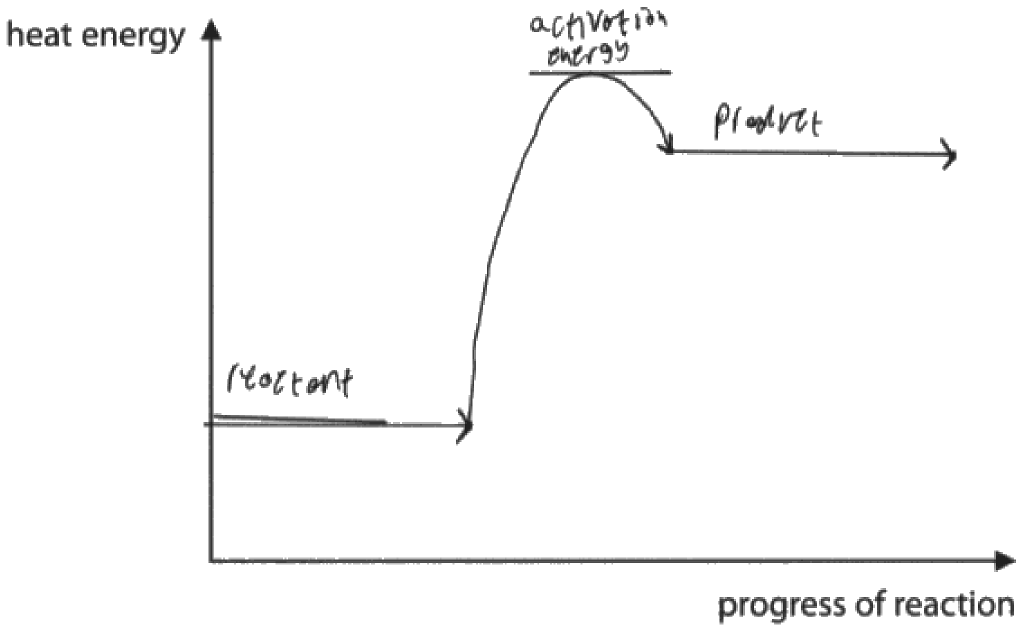
Consequential marking was in place for those who drew an exothermic reaction profile.

Incorrect diagrams included random straight lines starting from the origin, others drew a line similar to that produced from a rates of reaction curve and a few candidates drew curves to show what happened to the amount reactant and to the amount of product formed during a reaction.

(ii) In a cracking reaction, reactants are heated to form products.
This reaction is endothermic.

On the axes provided, draw the reaction profile of this reaction.
Label the energy of the reactants, the energy of the products and the activation energy of the reaction.

(3)



ResultsPlus
Examiner Comments

This response scored 2 of the 3 marks available.

A profile has been drawn for an endothermic reaction, with the relative positions of the reactants and products labelled and shown correctly. However, the activation energy is not labelled correctly, so limiting this response to 2 marks.

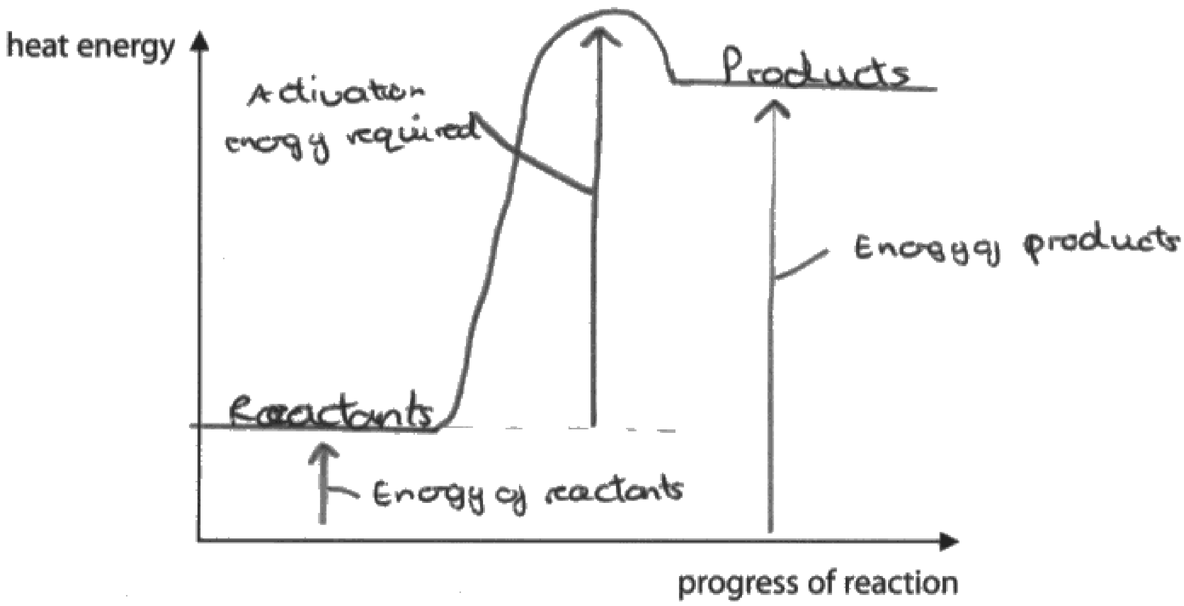
ResultsPlus
Examiner Tip

Make sure that not only can you draw the reaction profiles for both endothermic and exothermic reactions that you can label the activation energy on the profiles for both these types of reaction.

(ii) In a cracking reaction, reactants are heated to form products. This reaction is endothermic.

On the axes provided, draw the reaction profile of this reaction. Label the energy of the reactants, the energy of the products and the activation energy of the reaction.

(3)



ResultsPlus
Examiner Comments

An example of a fully correct response which scored 3 marks.

A profile has been drawn for an endothermic reaction, with the correct relative positions of the reactants and products labelled, with the activation energy also labelled correctly.

Question 6 (d) (iii)

Most candidates were able to work out the formula of the single product needed to balance the equation for the cracking of dodecane by writing C_6H_{14}. A common incorrect response seen here was to give $2C_3H_7$ as the answer, despite the question stating that the formula of a single molecule was needed to balance the equation.

Question 7 (a)

Generally poorly answered with majority of the candidates unable to score either of the 2 marks available.

A minority of candidates scored only 1 mark on the second marking point for recognising that colour of bromine in solution. Very few identified the colourless state of the solution at the start.

Common errors, omissions, misconceptions:

Many candidates clearly confused this with the test for alkenes and gave the colour change the wrong way round. Many candidates added incorrect observations, usually either referring to a precipitate of some colour, often cream or buff – presumably thinking of silver bromide – or to effervescence, the default observation. Many candidates, though, either missed the word 'seen' in the question, even though it was emboldened, or were just so unused to practical work that they could only talk in terms of chlorine displacing bromine.

7 (a) Describe what is **seen** when chlorine water is added to potassium bromide solution and the mixture shaken.

(2)

~~at~~ You will see a change in colour ~~from~~ as potassium chloride is formed. You will also see a slight fizzing.

ResultsPlus
Examiner Comments

This response was not creditworthy.

No starting colour is mentioned, so the first marking point is not awarded. Likewise, neither is a final colour mentioned, so the second marking point is not awarded. Even if a correct final colour had been given, the second marking point would not be awarded as there is an additional incorrect observation, namely 'fizzing'.

7 (a) Describe what is **seen** when chlorine water is added to potassium bromide solution and the mixture shaken.

(2)

The chlorine displaces the potassium bromide soloution turning the soloution to ~~[illegible]~~ orange as a result to show a reaction has occured.

ResultsPlus
Examiner Comments

This response scored only 1 of the 2 marks available.

The starting colour has not been given in the response, just a correct final colour, namely 'orange', so this scores 1 mark only.

ResultsPlus
Examiner Tip

In questions requiring observations involving a change in colour, always state both the starting and final colours.

Question 7 (b)

Generally very poorly answered, with few candidates scoring any of the 4 marks in either of the two parts to this question.

Similar to the previous question, 7(a), only a small number could give an appropriate explanation in part (i) and a correct half equation in part (ii). The most frequent mark awarded was for explaining that chlorine has been reduced by gaining electrons, but this was not awarded if this was incorrectly qualified by saying that the electron came from the potassium. Very few candidates stated that the product of the reduction was the chloride ion.

Overall, the ionic equation was very poorly attempted. In most cases, where attempted, the bromide ion had no charge, the electrons were being added to the bromide ions or some form of equation was written in reverse. It would seem that many candidates were not familiar with half equations.

(b) Chlorine reacts with potassium bromide to form potassium chloride and bromine.
In this reaction chlorine forms chloride ions

$$Cl_2 + 2KBr \rightarrow 2KCl + Br_2$$

(i) In this reaction, chlorine has been reduced.

Explain, using the equation, how you know that chlorine has been reduced.

(2)

Reduction is the gain of electrons therefore, as chlorine is a non-metal it ~~requires~~ aquires electrons to have a full stable electron structure when it becomes a compound therefore the chlorine ~~atom~~ molecule (Cl_2) gains electrons to become a chlorine ion as a compound with potassium (2KCl)

(ii) Write the half equation for the formation of bromine from bromide ions.

$2Br^- \rightarrow Br_2 + 2e$

(2)

$2Br^- \rightarrow Br_2 + 2e$

ResultsPlus
Examiner Comments

This response scored 1 of the 2 marks available for part 7(b)(i):

There is a reference to 'chlorine gains electrons' which scores on the first marking point. However, the incorrect reference to the formation of a 'chlorine ion', as opposed to the correct species, 'a chloride ion' means that the second marking point is not scored.

This response scored the 2 marks available for part 7(b)(ii):

The half equation for the formation of bromine from bromide ions is correctly constructed and balanced.

Question 7 (c)

Generally poorly answered with the majority of candidates scoring 1 mark only of the 3 available.

The most commonly seen responses scored 1 mark either for the left hand side or the right hand side – but few candidates managed both. Few candidates were able to correctly write a balanced equation. There were a few lost marks through a capital L as the second letter in a symbol.

(c) Aluminium reacts with chlorine to form aluminium chloride.

Write the balanced equation for this reaction.

Al^3 Cl^-

$AlCl_3$

Al + 3Cl → $AlCl_3$

ResultsPlus
Examiner Comments

This response scored 1 of the 3 marks available.

The response is awarded 1 mark for the correct formula of aluminium chloride shown on the right hand side of the equation. The formula of chlorine shown on the left hand side of the equation is incorrect since the subscripted 2 is missing from the formula. The balancing mark cannot be awarded, since it is dependent on the correct formulae of all species being shown.

ResultsPlus
Examiner Tip

Ensure that you can write the formula for the simple molecules used in the specification, *e.g.* remember that the formula of a molecule of chlorine is Cl_2.

(c) Aluminium reacts with chlorine to form aluminium chloride.

Write the balanced equation for this reaction.

(3)

$2Al + Cl_2 \rightarrow 2AlCl$

ResultsPlus
Examiner Comments

This response scored 1 of the 3 marks available.

The response is awarded 1 mark for the correct species, namely Al + Cl_2, shown on the left hand side of the equation. The formula of aluminium chloride shown on the right hand side of the equation is incorrect. The balancing mark cannot be awarded, since it is dependent on the correct formulae of all species being shown.

Question 7 (d)

Generally not well answered on the whole, with few candidates scoring the 3 marks available.

Describing the simple experiment here involved stating how the experiment could be carried out and how that experiment would show that ions would be present. About half the candidates gained a mark for stating that either the idea of the solution conducts electricity or use electrolysis. Only half of those gave some detail such as describing the circuit or inserting electrodes. Few gave an appropriate observation to show that ions were present.

Common errors, omissions, misconceptions:

Many candidates seemed to think that ions could be observed in solution moving towards the appropriate electrode. Most of the errors centred around measuring the boiling point of the solution or similar or flame tests or (often specific) precipitation tests for ions were mentioned.

(d) A solid ionic compound is dissolved in water to form a solution.

Describe a simple experiment to show that charged particles are present in this solution.

(3)

Electrolysis who show there are charged particles since only they can carry an electric current. One could connect electrodes to a power pack, ~~b~~ turn the power pack on and observe the solution for bubbles since a gas will be produced at the anode. Thus, showing that the electric current can be ~~carried~~ carried through the solution, due to the charged particles.

ResultsPlus
Examiner Comments

This response scored the 3 marks available.

Although not perfect, the candidate has correctly suggested that electrolysis can be used, using electrodes connected to a powerpack and a correct possible observation, bubbles, which might be seen at one electrode.

(d) A solid ionic compound is dissolved in water to form a solution.

Describe a simple experiment to show that charged particles are present in this solution.

(3)

You can use electrolysis. Put a cathode and anode in the solution, run a current through it and if something occurs then a charge is present.

ResultsPlus
Examiner Comments

This response scored 2 of the 3 marks available.

The first marking point is awarded for the use of a cathode and an anode. The second marking point is awarded for the use of electrolysis or alternatively for running a current through the solution. The third marking point is not awarded, since the reference made to 'see if something occurs' is not enough for to convey decomposition.

Question 8 (a)

Very few candidates were able to correctly name both the anion and cation from the results of the qualitative tests given in the table. Many were able to identify calcium as the cation only for 1 mark.

The most common error was to incorrectly state chlorine, rather than chloride ion as the anion.

8 Qualitative tests are used to identify ions in compounds.

(a) Solid **X** contains two ions.

The tests for these ions and their results are shown in Figure 10.

Li - red
Na = yellow
Ca = orange-red

test	result
flame test on solid **X**	red-orange flame
dilute nitric acid is added to an aqueous solution of **X**, followed by silver nitrate solution	white precipitate forms

Figure 10

Use the information in Figure 10 to name the cation and the anion in solid **X**.

(2)

name of cation .... calcium ....

name of anion .... chlorine ....

ResultsPlus
Examiner Comments

This response scored 1 of the 2 marks available.

The cation is correctly named. However, the anion is incorrectly named as 'chlorine', as opposed to 'chloride'.

ResultsPlus
Examiner Tip

Remember that it is a chlor**ide** ion and not a chlorine ion.

8 Qualitative tests are used to identify ions in compounds.

(a) Solid **X** contains two ions.

The tests for these ions and their results are shown in Figure 10.

test	result	
flame test on solid **X**	red-orange flame	calcium
dilute nitric acid is added to an aqueous solution of **X**, followed by silver nitrate solution	white precipitate forms	chloride

Figure 10

Use the information in Figure 10 to name the cation and the anion in solid **X**.

(2)

name of cation ....Chloride........

name of anion ....calcium........

ResultsPlus
Examiner Comments

This response was not creditworthy and was seen in several responses which did not score.

Unfortunately, despite identifying the correct ions from the results of the tests given in the table, this candidate has not understood the terms cation and anion and written the names in the incorrect places.

ResultsPlus
Examiner Tip

Make sure that you can describe an anion as negatively charge ion and a cation as a positively charged ion.

Question 8 (b) (i)

Generally poorly answered, with about two fifths of response scoring the 1 mark available, mainly by reference that aluminium and calcium ions would both give white precipitates.

It would seem that some candidates did not know which ions are anions and which are cations which made this item and the next somewhat tricky. Many candidates referred to the absence of flame tests.

(b) Another solid, **Y**, also contains two ions.

A test was carried out on solid **Y**.

A few drops of sodium hydroxide solution were added to a solution of solid **Y**.
A white precipitate formed.

(i) Give the reason why this test does not identify the cation in solid **Y**.

(1)

Because when adding Sodium hydroxide to calcium and aluminium, they both form a white precipitate so you wouldn't be able to tell.

ResultsPlus
Examiner Comments

This response scored the 1 mark available.

The response gives a correct reason by reference to calcium and aluminium - showing for this test that more than one cation gives the white precipitate.

(b) Another solid, **Y**, also contains two ions.

A test was carried out on solid **Y**.

A few drops of sodium hydroxide solution were added to a solution of solid **Y**. A white precipitate formed.

(i) Give the reason why this test does not identify the cation in solid **Y**.

(1)

~~Because it shows the anion.~~
~~Because the sodium displaces substance.~~
Because it does not show positive ions

ResultsPlus
Examiner Comments

This is a typical response which was not creditworthy.

An incorrect statement is made to the effect that this test does not show positive ions.

Question 8 (b) (ii)

Generally very poorly answered, with the majority of responses not scoring the 1 mark available.

Some candidates gave exactly the same answer as they had written for the previous item concerning cations. This was poorly understood.

(ii) Give the reason why this test does not identify the anion in solid **Y**.

(1)

As the hydroxide test does not test for negative ions only positive.

ResultsPlus
Examiner Comments

This response scored the 1 mark available.

A correct statement is made to the effect that this test does not test for negative ions and only tests for positive ions.

(ii) Give the reason why this test does not identify the anion in solid **Y**.

(1)

This a test for negatively charged ions.

ResultsPlus
Examiner Comments

This response was not creditworthy.

The student may have missed out a couple of words, such as 'is not' (a test for negatively charged ions). However, quite clearly the final answer is incorrect and does not score.

ResultsPlus
Examiner Tip

It is worthwhile checking the wording of your answer to see if it makes sense.

Question 8 (c)

Generally very well answered, with the majority of responses scoring the 1 mark available.

Many responses clearly indicated that candidates were aware of one, or often more, of the advantages of instrumental methods – 'improve accuracy' being the most common response.

(c) Instrumental methods are often used for analysis.

Give a reason why instrumental analysis may be better than other methods of analysis.

(1)

It improves sensitivity, speed and accuracy

ResultsPlus
Examiner Comments

This response scored the 1 mark available.

All three reasons would have equally scored the mark.

(c) Instrumental methods are often used for analysis.

Give a reason why instrumental analysis may be better than other methods of analysis. **(1)**

They're more precise at reading the data

ResultsPlus
Examiner Comments

This response was not creditworthy.

The reference to 'more precise' is ignored and does not score.

Question 8 (d) (i)

Generally very poorly answered, with very few responses scoring any of the 3 marks available for ionic equation for the formation of iron(II) hydroxide.

Common errors, omissions, misconceptions:

Far too many candidates simply did not give an ionic equation. Many included spectator ions or gave full formulae. Others included charges in the formula of $Fe(OH)_2$.

(d) Iron(II) sulfate solution reacts with sodium hydroxide solution to form a pale green precipitate of iron(II) hydroxide, $Fe(OH)_2$.

$Fe\ S + S$ $\quad$ $Fe^{2+}S^{-2} + Na^{-}OH^{+} \rightarrow Fe(OH_2)_2$

(i) Write the ionic equation for this reaction. $Fe^{2+} + S^{-2} + Na_2^{+} + (OH)^{-} \rightarrow Fe^{-2}(OH)_2^{+} +$ **(3)**

$Fe^{2+} + 2OH^{-} \rightarrow Fe^{2}(OH)_2^{+}$

ResultsPlus
Examiner Comments

This is a typical response which scored only 1 of the 3 marks available.

The ions on the left hand side of the equation, Fe^{2+}, and OH^{-}, are correctly written and score the first marking point. The formula for iron(II) hydroxide shown on the right hand side of the equation is incorrect since charges are still on ions and they are also incorrect. The third marking point for balancing cannot be scored since not all the species in this equation are correct.

ResultsPlus
Examiner Tip

Remember when writing the formula for an ionic compound in ionic equations, such as the iron(II) hydroxide in this question, do not include charges on the formula.

(d) Iron(II) sulfate solution reacts with sodium hydroxide solution to form a pale green precipitate of iron(II) hydroxide, $Fe(OH)_2$.

(i) Write the ionic equation for this reaction.

(3)

~~$FeSO_4$~~ $Fe^{2+} + 2\ OH^- \rightarrow 2\ Fe(OH)_2$

ResultsPlus
Examiner Comments

This response scored 2 of the 3 marks available.

The species on both sides of the equation are correctly written, which scores the first two marking points. However, the extra balancing coefficient, 2, in front of the iron(II) hydroxide on the right hand side means the balancing is incorrect, so the third marking point cannot be scored.

Question 8 (d) (ii)

This was poorly answered with only half the candidates able to score 1 or 2 of the 2 marks available.

The most commonly seen correct response was for mentioning that iron (III) hydroxide was produced, for the second marking point.

Most responses for this item were simply too vague, with many mentioning about iron rusting and consequently did not score.

(ii) The green (aq) iron(II) hydroxide precipitate gradually turns brown when exposed to air.

Explain this observation.

(2)

The iron is oxidised, which means that the iron will lose one more electron to form Iron (III). Iron (III) hydroxide is a brown precipitate.

ResultsPlus
Examiner Comments

This response scored 1 of the 2 marks available.

The product, iron(III) hydroxide, is correct and scores on marking point 2. However, the first marking point is not awarded since 'iron' alone is not specific and not acceptable for iron(II).

(ii) The green iron(II) hydroxide precipitate gradually turns brown when exposed to air.

Explain this observation.

(2)

The iron (II) hydroxide may oxidise to form iron (III) hydroxide, and Fe^{3+} forms a brown precipitate, which is likely what occured during the observation.

(Total for Question 8 = 10 marks)

$Na^{+} + OH^{-} \rightarrow 2OH^{-} + 2Na^{+}$

SO_4^{2-}

$Fe^{2+} + SO_4^{2-} + Na^{+} + OH^{-} \rightarrow Fe^{2+} + 2OH^{-} + 2Na^{+} + SO_4^{2-}$

$FeSO_4 + NaOH \rightarrow Fe(OH)_2 + Na_2SO_4$

$SO_4^{2-} + Na^{+} \rightarrow Fe(OH)_2$

ResultsPlus
Examiner Comments

This response scored the 2 marks available.

The response mentions that iron((II) hydroxide may oxidise to form iron(III) hydroxide which scores both marking points. Although not perfectly worded, in respect of the term 'may oxidise', rather than 'is oxidised', the correct idea is sufficient to gain credit, since at this level, students will unfamiliar with 'oxidising agents'.

Question 9 (a) (i)

The majority of candidates gave an appropriate means of measuring the volume of gas more accurately and of those the overwhelming majority gave 'gas syringe' as their answer.

The most common error gave an answer that involved measuring the mass rather than the volume.

Question 9 (a) (ii)

The majority of responses scored both of the 2 marks available.

Most candidates made an attempt at calculating the gradient at the point shown by using the tangent line. An answer of 0.5 was as common as the best answer of 0.47.

Some made errors in reading the graph to calculate the gradient. The most obvious error seen was where candidates calculated the average gradient by dividing the volume at that point (29 cm^3) by the time (30 s), scoring 1 mark for an incorrect fraction correctly evaluated.

(ii) A tangent has been drawn to the line on the graph in Figure 12.

Calculate the rate of reaction at this point.

(2)

(20, 24.6) (40, 34)

$\frac{34 - 24.6}{40 - 20} = \frac{47}{100} = 0.47$

rate of reaction = 0.47 $cm^3 s^{-1}$

ResultsPlus
Examiner Comments

This response scored the 2 marks available, for a calculated value for the rate of reaction within the accepted range. Although the final answer alone scores full marks, from the working shown, it is clear how the candidate has used the tangent to the graph to calculate the gradient.

Question 9 (a) (iii)

This was not well answered on the whole, with less than half responses scoring the 1 mark available for sketching an appropriate graph showing the behaviour of an equal mass of powdered magnesium.

Many candidates omitted this question. Is it possible that they simply did not recognise that there was a question there to be answered.

The most common error was where no line was shown, other errors included a straight line going through the origin diagonally across the grid, where the line levelled off either above or below 40 cm^3.

The graph in Figure 12 shows the results of this experiment.

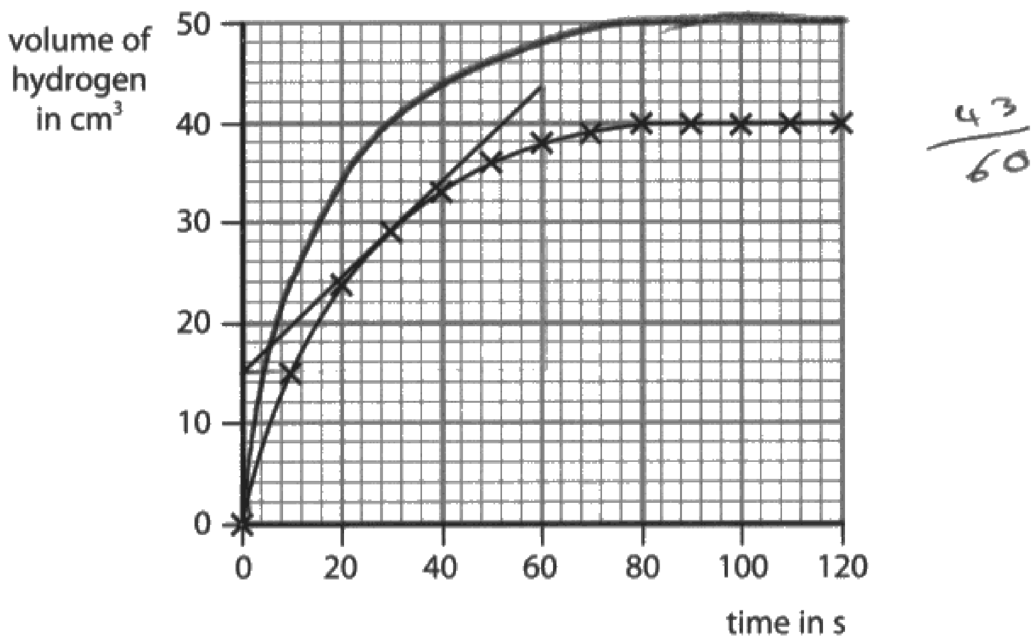


Figure 12

(iii) On the graph in Figure 12, draw the line you would expect to obtain if the magnesium ribbon in this experiment was replaced with an equal mass of powdered magnesium. All other conditions are kept the same.

(1)

ResultsPlus
Examiner Comments

This response did not score the 1 mark available.

Although the curve is steeper and correctly drawn to the left of the printed curve, it is incorrectly drawn above 40cm^3, so the mark is not scored.

The graph in Figure 12 shows the results of this experiment.

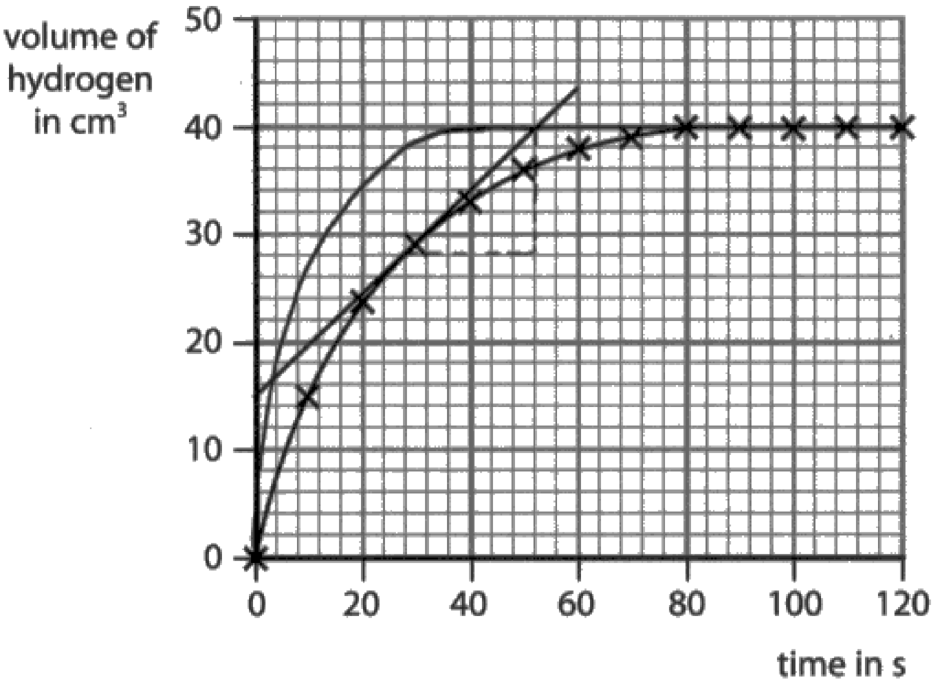


Figure 12

(iii) On the graph in Figure 12, draw the line you would expect to obtain if the magnesium ribbon in this experiment was replaced with an equal mass of powdered magnesium. All other conditions are kept the same.

(1)

ResultsPlus
Examiner Comments

This response scored the 1 mark available.

The line drawn is a curve to the left of the printed curve and also reaches the same final volume, 40 cm^3.

Question 9 (b) (i)

This was not well answered on the whole, with less than half responses scoring the 1 mark available for correctly calculating the number of moles of magnesium. The most common response seen was 0.00416 (dot over 6). Relatively few rounded to 0.0042, most that rounded going to 0.004. Very few answers were given in standard form.

There were many candidates who used the two numbers of 0.1 and 24 in various other ways such as 24/0.1 or 0.1 x 24.

Of those who had the numbers in a correct fraction, some spoilt their answers by an incorrect approximation – 0.0416 is incorrect. Equally, leaving the answer as 0.1/24 was not accepted, the evaluation of the fraction is expected as the answer.

(b) The balanced equation for this reaction is

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

(i) In another experiment, 0.1 moles of hydrochloric acid, HCl, were reacted with 0.1 g of magnesium ribbon.

Calculate the number of moles of magnesium, Mg, in the 0.1 g sample of magnesium ribbon.
(relative atomic mass: Mg = 24)

(1)

Moles = $\frac{mass}{Mr}$ $\frac{0.1}{24} = 0.0041\dot{6}$

number of moles = $0.0041\dot{6}$

ResultsPlus
Examiner Comments

This response scored the 1 mark available.

The candidate has recalled and used the correct formula needed to calculate the number of moles. Importantly, this has been correctly evaluated to give 0.00416 (with dot over the 6), which scores the mark.

(b) The balanced equation for this reaction is

0.1g   0.1moles

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

(i) In another experiment, 0.1 moles of hydrochloric acid, HCl, were reacted with 0.1 g of magnesium ribbon.

Calculate the number of moles of magnesium, Mg, in the 0.1 g sample of magnesium ribbon.
(relative atomic mass: Mg = 24)

moles = $\frac{mass}{mr}$

(1)

$= \frac{0.1}{24} =$

number of moles = 4.17

ResultsPlus
Examiner Comments

This response did not score the 1 mark available.

The correct calculation has been shown, namely 0.1 / 24. This has not been evaluated and consequently cannot score the mark.

Question 9 (b) (ii)

Generally very poorly answered, with very few responses scoring the 1 mark available.

Only a few candidates understood the question as evidenced by how many scored the one mark. Many just left a blank space or rewrote the equation. Many tried to justify their answer by use of relative atomic masses.

(ii) In a further experiment, 0.5 mol of hydrochloric acid, HCl, were mixed with 0.5 mol of magnesium, Mg.

Use the equation to show that, in this experiment, the magnesium is in excess.

(1)

Ratio of Mg : HCl = 1 : 2

= 0.25 : 0.5

The magnesium is 0.25 mol in excess.

ResultsPlus
Examiner Comments

This response scored the 1 mark available.

The candidate correctly identifies the ratio of magnesium : hydrochloric acid and then goes on to show how much excess magnesium is present.

(ii) In a further experiment, 0.5 mol of hydrochloric acid, HCl, were mixed with 0.5 mol of magnesium, Mg.

1 + 35.5 = 36.5

Use the equation to show that, in this experiment, the magnesium is in excess.

(1)

0.5 mol of Mg = ~~79~~ 12 g — HCl needs to be

∴ 0.5 mol of HCl = 18.25 g — twice as abundant as magnesium.

ResultsPlus
Examiner Comments

This response was not creditworthy.

The candidate is attempting to use a ratio of masses to explain why hydrochloric acid is not in excess. However, this is incorrect as the stoichiometric coefficients in the equation are a ratio of moles.

Question 9 (c)

Looking at the overall marks awarded for all the candidates, the majority candidates scored at least a Level 2 (3 or 4 marks). It is clear that many candidates have a good understanding of the effect of temperature and concentration on the rate of reaction and a good number scored highly on this item.

The typical Level 1 answer contained a simple application of the data such as increasing the temperature increased the rate of reaction. To get to Level 2, it was necessary for candidates to make direct reference to data given in the question and with some explanation in terms of particles and both the effects of concentration and temperature. A Level 3 answer needed an explanation of the connection between both temperature and concentration, shown by the data, and reaction rate together with explanations in terms of particles and collisions.

Some candidates gave very good explanations but failed to link their explanations to the data given in the table and were limited to Level 1. Also, candidates that talked about the effects of temperature and concentration on rates but did not explain them at all in terms of particles or collisions, were limited to Level 1. In general, many candidates have difficulty with giving sufficient detail in their explanations for the effects of changing different variables, so a reference to increased concentration was often characterised as just more particles rather than more particles per unit volume, higher collision frequency as just more collisions.

*(c) Two substances, **A** and **B**, each form a colourless solution.
If the solutions are mixed in a beaker, **A** and **B** react to form a coloured product.
The rate of the reaction between **A** and **B** can be investigated by placing the beaker containing the mixture on a cross on a piece of paper and timing how long it takes for enough coloured product to be produced to make the cross invisible when viewed from above, through the solution.

	experiment 1	experiment 2	experiment 3
concentration of **A in solution** in g dm^{-3}	10	10	40
temperature in °C	20	40	40
time for cross to become invisible in s	320	80	20

Figure 13

Use the results of these experiments to explain, in terms of the behaviour of particles, the effect of changing temperature and the effect of changing the concentration of **A** in solution on the rate of this reaction.

(6)

Changing the concentration of A ~~the~~ effects the time taken as it means that there are more particles in a smaller space, due to this the particles are going to bump into each other more often there for reacting more often which means the rate of reaction increases when concentration is increased.

Changing the temperature will increase the rate of reaction due to the particles having more energy so they move around at a greater speed meaning they will bump into other particles more often, therefor react more often and rate of reaction increases.

ResultsPlus
Examiner Comments

This response was awarded a Level 1, 2 marks.

The effects on the rate of reaction of changing temperature and concentration of **A** are discussed and are explained in terms of particles and collisions. However, the stem of this question very clearly instructs candidates to 'use the results of these experiments'. It is clear from the response that data from the table has not been used to compare the different conditions. Consequently, this response is limited to a Level 1.

ResultsPlus
Examiner Tip

Read the question carefully, especially when data is provided and the question instructs the candidate to use the data. Failing to use this information, as in this particular example, is likely to limit the Level that can be awarded.

*(c) Two substances, **A** and **B**, each form a colourless solution.
If the solutions are mixed in a beaker, **A** and **B** react to form a coloured product.
The rate of the reaction between **A** and **B** can be investigated by placing the beaker containing the mixture on a cross on a piece of paper and timing how long it takes for enough coloured product to be produced to make the cross invisible when viewed from above, through the solution.

	experiment 1	experiment 2	experiment 3
concentration of **A in solution** in g dm^{-3}	10	10	40
temperature in °C	20	40	40
time for cross to become invisible in s	320	80	20

Figure 13

Use the results of these experiments to explain, in terms of the behaviour of particles, the effect of changing temperature and the effect of changing the concentration of **A** in solution on the rate of this reaction.

(6)

In experiment 1, the temperature was relatively low and the concentration was too. This produced the longest time for the cross to become invisible at 320 seconds. This is because there is little energy to increase the frequency of collisions ~~e~~ which, ~~to~~ in effect would increase the rate of reaction. In experiment 2, the concentration was kept the same (at 10 g dm^{-3}) ~~[illegible]~~ but the temperature was doubled (increased to 40°c). This produced a time of 80 seconds (four times quicker than experiment 1). This is because there is more available energy for the frequency of collisions to increase, therefore for the rate of reaction to increase within the solution. In experiment 3, the temperature was kept the same at 40°c however the concentration was

increased to 40 g dm^{-3} which produced a time of 20 seconds for the cross to disappear (four times quicker than in experiment 2). This is because because there is
there is ~~a lot of~~ a higher concentration of A in the solution - it gives the reaction more energy to increase the rate at which it reacts.

ResultsPlus
Examiner Comments

This response was awarded a Level 2, 4 marks.

Data from the table is used and both the effects of temperature and concentration are discussed. Collisions are used in the explanations. However, particles or collisions are not used correctly in the explanation of concentration, therefore a Level 3 cannot be reached. Hence a Level 2 was awarded.

*(c) Two substances, **A** and **B**, each form a colourless solution.
If the solutions are mixed in a beaker, **A** and **B** react to form a coloured product.
The rate of the reaction between **A** and **B** can be investigated by placing the beaker containing the mixture on a cross on a piece of paper and timing how long it takes for enough coloured product to be produced to make the cross invisible when viewed from above, through the solution.

	experiment 1	experiment 2	experiment 3
concentration of **A in solution** in g dm^{-3}	10	10	40
temperature in °C	20	40	40
time for cross to become invisible in s	320	80	20

← use results!

Figure 13

thermal, kinetic → particles move faster → more likely to collide → more successful collisions with activation energy

collision theory

Use the results of these experiments to explain, in terms of the behaviour of particles, the effect of changing temperature and the effect of changing the concentration of **A** in solution on the rate of this reaction.

→ increase amount of particles, more likely to collide, more likely to collide successfully with enough activation energy

(6)

Changing the temperature of 'A' in solution affects the rate of reaction, because thermal energy is transferred to kinetic energy. This then allows the particles to ~~more~~ move faster, which means that they are more likely to collide. More collisions means more successful collisions with enough activation energy. For example, the temperature in experiment 1 was 20°c, and the ~~ta~~ time taken for the cross to become visible was 320 seconds. However, when the temperature was increased to 40°c in experiment 3, the time taken was only 20 seconds. This shows that as you increase the temperature, the

rate of reaction also increases.
Changing the concentration of 'A' in solution affects the rate of reaction, because it increases the concentration of particles in a given volume. Increasing the concentration of particles means that they are more likely to collide successfully with enough activation energy. For example, the concentration in experiment 2 was 10 g dm^{-3} and the time taken was 80 seconds. However, when the concentration was increased at 40 g dm^{-3}, the time taken was only 20 seconds, which was 60 seconds faster than experiment 2. This shows that if you increase the concentration, the rate of reaction also increases.

Overall, if you increase the temperature and concentration of the solution, the rate will increase at the best rate, for example in experiment 3.

(Total for Question 9 = 12 marks)

ResultsPlus
Examiner Comments

This response was awarded a Level 3, 6 marks.

Data from the table is used and all three experiments in relation to the effects of both temperature and concentration are discussed. Both temperature and concentration are explained in terms of particles and collisions. There is a slip in experiment numbers on the first page but it is clear what experiments are being considered. Hence a Level 3 is scored. There is also a good conclusion at the end.

Even if the answer space had been blank, some credit could have been awarded for the annotation or plan by the table.

Question 10 (a)

Generally well answered on the whole with the majority of candidates able to score 3 or 4 of 4 marks available.

Most candidates understood the need to sum bond energies of reactants and products and subtract the two results. Thus, they often scored some marks for correctly carrying forward incorrect number(s). It was noted by examiners that it was sometimes difficult to establish from a poorly laid out response what the candidate was doing.

10 (a) Hydrogen reacts with oxygen to form steam.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

Bond energies are shown in Figure 14.

bond	bond energy in kJ mol^{-1}
H—H	435
O═O	500
O—H	460

Figure 14

Calculate the energy change for the reaction of 2 mol of hydrogen gas, H_2, with 1 mol of oxygen gas, O_2, to give 2 mol of steam, H_2O.

(4)

2 H−H + O=O → 2 H−H−O

2 ~~(...)~~ (435) + 500 → 2 (435+460)

1370 → 1790

1370 − 1790 = −420

energy change = −420 kJ mol^{-1}

ResultsPlus
Examiner Comments

This response scored 3 of the 4 marks available.

The energy needed to break bonds (1370) is correctly evaluated, so the first marking point is scored. The energy released (1790) is incorrectly evaluated (one 0-H and one H-H), so the second marking point is not scored.
The difference between the two energies is correctly evaluated (1370 - 1790 = -420), so the third marking point is scored by error carried forward. The energy change is correctly shown with negative sign, so the fourth marking point is also scored.

10 (a) Hydrogen reacts with oxygen to form steam.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

Bond energies are shown in Figure 14.

bond	bond energy in kJ mol^{-1}
H—H	435
O═O	500
O—H	460

Figure 14

Calculate the energy change for the reaction of 2 mol of hydrogen gas, H_2, with 1 mol of oxygen gas, O_2, to give 2 mol of steam, H_2O.

(4)

2H2 + O2 → 2H2O
(435x2) (500x2) (460x2)
870 + 1000 → 920
1870 - 920 = 950

energy change = 950 kJ mol^{-1}

ResultsPlus
Examiner Comments

This response scored 1 of the 4 marks available.

Both sets of bond calculations, namely to calculate the energies needed to break and make bonds, are incorrect so neither of the first two marking points are scored. The difference between the two energies is correctly calculated so the third marking point is scored by error carried forward. As calculated from the incorrect answers to first two marking points, the energy change should be positive showing energy absorbed. To score this mark by error carried forward, the candidates must show a + sign or say 'energy absorbed', which is not shown in this particular response, so the fourth marking point cannot be scored.

Question 10 (b)

Looking at the overall marks awarded for all the candidates, this was poorly answered, with a wide range of marks and many students unable to recall simple qualitative tests and the expected results for alkenes or acids.

The most common correct answer related to identifying hexene by testing with bromine water, followed by identifying the acid with a named indicator, usually litmus. The most common correct balanced equation was for hexene and bromine.

The typical Level 1 answer contained one correct test for 1 mark; two correct tests given or alternatively, one correct test with correct result given for 2 marks. To get to Level 2, it was necessary for candidates to give two correct tests with correct results for two different compounds or a correct test and correct result with a correct symbol equation for that test. A Level 3 answer needed two correct tests with correct results given for two different compounds with a balanced symbol equation.

Relatively few candidates gave a correct balanced equation with almost none managing the reaction between the acid and a carbonate. Candidates frequently failed to understand the information given in the question, adding hydrochloric acid to the butanoic acid solution and expecting it to give off carbon dioxide or adding hydrochloric acid and then performing the tests for an acid. Some candidates showed a lack of understanding of the difference between a test for a substance and a reaction of the substance. So candidates attempted to test for hexane by cracking it. Some attempted to test for butanoic acid by esterifying it, ignoring that it was in aqueous solution and also ignoring the pointers in the question.

*(b) A student is provided with unlabelled samples of three liquids.
The three liquids are known to be

hexane, C_6H_{14}, a liquid alkane
hexene, C_6H_{12}, a liquid alkene
butanoic acid, $C_4H_8O_2$, a carboxylic acid, in aqueous solution

Aqueous solutions of carboxylic acids contain hydrogen ions and undergo reactions typical of acids with indicators and carbonates.

Describe, in detail, using the information given and your knowledge of the reactions of these liquids, tests the student should carry out to identify each of the three liquids.

You should include balanced equations for any chemical reactions described.

(6)

~~A~~ The alcane and alkene both are hydrocarbons which means that only hydrogen and carbon are present.

To identify the carboxylic acid from the you could ~~[illegible]~~ dip a piece of blue litmus paper into the liquids. The one that turn the litmus paper red can be identified as ~~the~~ the butanoic acid, C4H8O2.

alkene - unsaturated

alcane - saturated

ResultsPlus
Examiner Comments

This response was awarded a Level 1, 2 marks.

A correct test for the carboxylic acid and a correct result of this test have been mentioned, namely the use of an indicator, blue litmus paper which would turn red in the presence of the butanoic acid. This is sufficient for a Level 1 response.

*(b) A student is provided with unlabelled samples of three liquids.
The three liquids are known to be
hexane, C_6H_{14}, a liquid alkane
hexene, C_6H_{12}, a liquid alkene
butanoic acid, $C_4H_8O_2$, a carboxylic acid, in aqueous solution

C – C – C – C

Aqueous solutions of carboxylic acids contain hydrogen ions and undergo reactions typical of acids with indicators and carbonates.

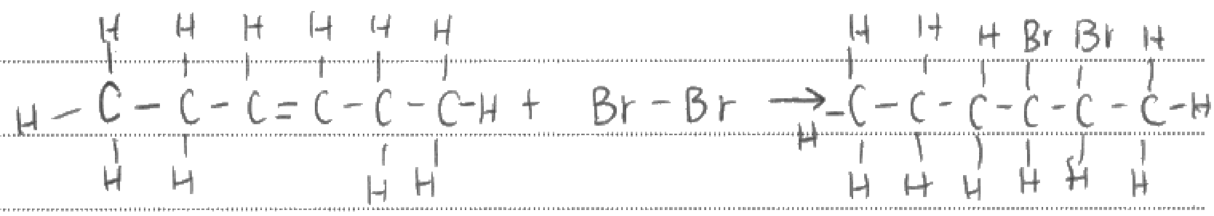
Describe, in detail, using the information given and your knowledge of the reactions of these liquids, tests the student should carry out to identify each of the three liquids.

You should include balanced equations for any chemical reactions described.

(6)

~~The student could test for the alkane (hexane) using the bromine water test. Because the other two~~

The student could test for the alkene (hexene) using the bromine water test. Because an alkene has a double bond and so is unsaturated it will react with the bromine water in an addition reaction and will cause it to turn colourless:



$$C_6H_{12} + Br_2 \longrightarrow C_6H_{12}Br_2$$

But because the alkane doesn't contain a double bond it won't react with the bromine water leaving the solution orange.

The problem is that carboxylic acids also have a double bond. So after this experiment the student should have 2 colourless solution and one orange. The orange one is obviously the alkane/hexane.

~~To test for the car~~ To identify the other two the student could ~~dip a wooden splint in both of the solutions~~ evaporate both liquids and put a glowing wooden splint into a test tube with either of the gas of the two liquids. The splint which relights show that oxygen is present and so the liquid from which this gas are made is the carboxylic acid

Furthermore he could test if one of the two liquids react with oxygen. The one which does is the alkene forming hexanoic acid. The other one is already a carboxylic acid and so won't react.

ResultsPlus
Examiner Comments

This response was awarded a Level 2, 4 marks.

A correct test for the alkene and a correct result of this test have been mentioned, namely the use of bromine water which turns colourless with the hexene. A correct balanced equation for this reaction has been given. This is sufficient for a Level 2 response.

There is no further creditworthy material in the rest of the response which would allow a correct identification of the butanoic acid or the hexane.

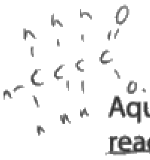
*(b) A student is provided with unlabelled samples of three liquids.

The three liquids are known to be

hexane, C_6H_{14}, a liquid alkane

hexene, C_6H_{12}, a liquid alkene

butanoic acid, $C_4H_8O_2$, a carboxylic acid, in aqueous solution



Aqueous solutions of carboxylic acids contain hydrogen ions and undergo reactions typical of acids with indicators and carbonates.

Describe, in detail, using the information given and your knowledge of the reactions of these liquids, tests the student should carry out to identify each of the three liquids.

You should include balanced equations for any chemical reactions described.

(6)

• To test for Hexene (alkene) the Student should add a few drop bromide water to the ~~liquid alkene~~ Samples and shake them. The liquid which contains the alkene will turn from ~~colourless~~ orange to colourless. The others will remain orange

alkene + bromine → alkene bromide (the double carbon bond breaks open and forms a bond with the bromine)

$C_6H_{12} + Br_2 \rightarrow C_6H_{12}Br_2$

• Butanoic acid in Solution will be acidic, The Student Should use blue litmus paper to identify the butanoic acid, the litmus paper will turn red if the solution is acidic, it will not turn red for the alkane or alkene because they are hydrocarbons (so don't contain Oxygen) and they are not in solution, so will not have OH^- ions ~~in solution~~ present to make them acidic

this is because they do not form bonds with the bromine, so it stays orange ($C_6H_{14} + Br_2 \rightarrow C_6H_{14} + Br_2$)

($C_4H_8O_2 + Br_2 \rightarrow C_4H_8O_2 + Br_2$)

The alkane will be the sample which gives a negative result for both of the tests.

ResultsPlus
Examiner Comments

This response was awarded a Level 3, 6 marks.

Two correct tests and correct results have been given. The bromine water test for an alkene with the correct colour changes for the three liquids; a balanced equation has been given for this reaction and an attempt to show that the other two liquids do not react. A correct test for identifying the carboxylic acid has been given, namely the use of blue litmus turning red and negative results with the other two liquids. This is sufficient for a Level 3 response.

Paper Summary

Based their performance on this paper, candidates are offered the following advice:

- Practice a variety of calculations as described in the specification.
- Learn the formulae of gases and simple compounds as used in the specification.
- Practise writing and balancing equations.
- Practise writing and balancing ionic equations.
- Practise writing half equations.
- Be able to explain the redox reactions occurring when displacement reactions occur when halogens react with halide ions.
- Learn the qualitative tests and the result of these tests for anions and cations in the specification.
- Learn the tests and the result of these tests for gases.
- Learn the meaning of terms used in the specification such as covalent bond, alkane, hydrocarbon and homologous series.
- Practise drawing reaction profiles for both exothermic and endothermic reactions.
- Practise answering extended open-response questions.
- To help with the above, there are plenty of examples in the sample assessment materials and examination papers of the previous specification which has similar coverage.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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