

# **Examiners' Report** **June 2024**

**GCSE Chemistry 1CH0 2H**

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## Introduction

Paper 1CH0/2H is the second of two papers in Higher Tier GCSE Chemistry . Six of the ten questions are also found in the second Chemistry paper of Higher Tier GCSE Combined Science. Some of the earlier questions in the paper overlap with Foundation Tier GCSE Combined Science and GCSE Chemistry.

## Question 1 (a)(i)

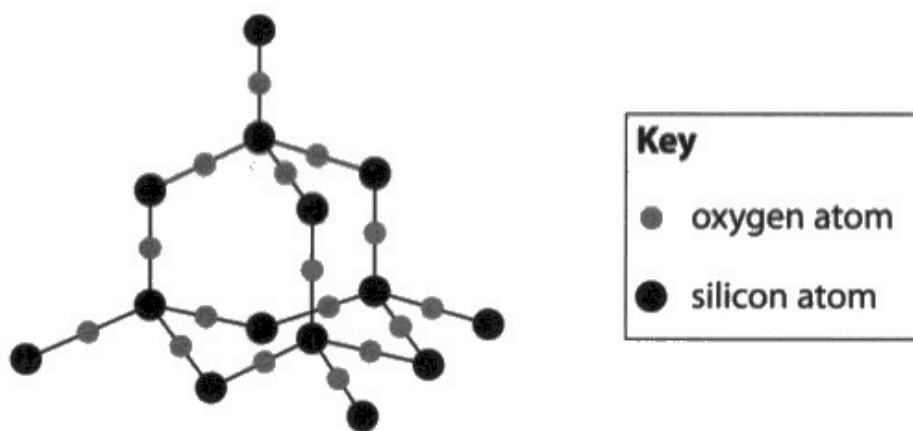
The majority of candidates were able to state the relationship between stone content and strength correctly, although the ability to word this appropriately and clearly was challenging for some. Common errors included to just state 'it gets stronger' without linking this to the amount of stone added, talking about the amount of sand and/or cement, or not using the data and saying that more stone led to a greater strength.

### Question 1 (a)(iii)

Many candidates were able to state correctly giant covalent, but not all gave the structure **and** bonding as required. 'Giant lattice' was regularly seen, with no reference to the type of bonding. Some recognised it was covalent bonding, but failed to classify it as a giant structure, giving other descriptions including lattice and tetrahedral. 'Large' covalent was a relatively common incorrect answer. Other misconceptions included the structure described as diamond, ionic and giant ionic lattice.

(iii) Sand contains silicon dioxide.

Figure 2 shows part of the structure of silicon dioxide.



**Figure 2**

State the type of structure and bonding in silicon dioxide.

(1)

covalent structure / bonding.



**ResultsPlus**  
Examiner Comments

This answer indicates that the bonding is covalent, but has not indicated the structure – giant covalent. (Covalent structure would also apply to simple molecules).

## Question 1 (b)(ii)

Most candidates had the idea that the sun cream blocks UV linked to the prevention of sunburn. Some were not specific enough – referring to the Sun, Sun's rays or sunlight instead of UV light. Many mentioned that it won't be visible on the skin. Some candidates answered this question with generic statements such as 'protects the skin' or 'doesn't cause harm' which did not score.

(ii) Some sunscreens contain nanoparticles of titanium dioxide.

Explain why nanoparticles of titanium dioxide are used in some sunscreens.

(2)

Nanoparticles of titanium dioxide are used in some sunscreens because they are transparent so don't leave white marks and reflect UV radiation from the sun, protecting you from sunburns.

(Total for Question 1 = 6 marks)



A good answer – has identified UV radiation as a problem and the fact that the 'reflection' of this protects from the specific medical issue of sunburn. (The fact that white marks are not left could also be credited).

## Question 2 (a)

The most common response here was gas syringe, however diagrams often did not have plungers or were entirely sealed. Not all candidates could correctly label the gas syringe – with labels including gas cylinder or glass syringe. Upright measuring cylinders were less commonly used, and some of these were directly connected to the delivery tube in a horizontal position. Blockages/seals were regularly drawn within gas syringes and measuring cylinders. Some methods could not be used to measure the gas, eg an upright test tube or boiling tube in water. Others surprisingly had other glassware after a gas syringe to collect the gas.

- 2 A student investigates the reaction between marble chips and dilute hydrochloric acid.

The student measures the total volume of carbon dioxide gas produced each minute, for 10 minutes.

- (a) Figure 3 shows part of the apparatus used in the experiment.

Complete Figure 3 by drawing and labelling apparatus that could be used to collect and measure the volume of the carbon dioxide gas.

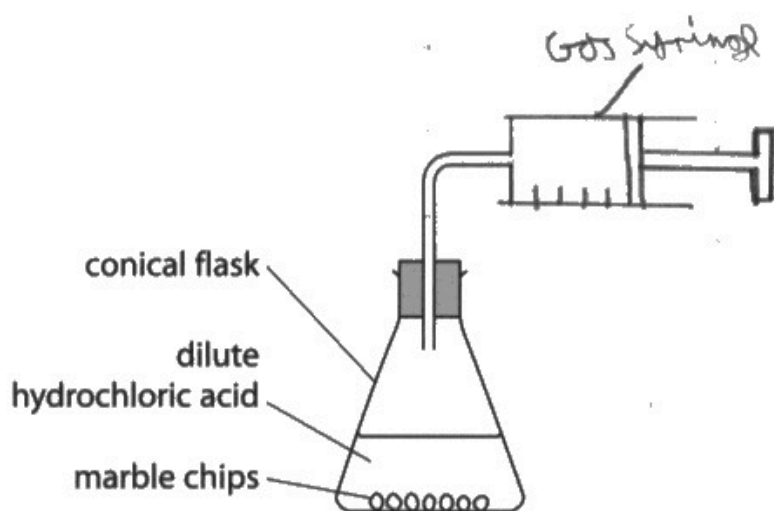


Figure 3



This is a clearly drawn and labelled gas syringe with no seals between the delivery tube and syringe.

## Question 2 (b)(i)

Most candidates could read from the graph correctly.

(b) Figure 4 shows a graph of the results of the experiment.

A tangent has been drawn on the curve at a time of 3.5 minutes.

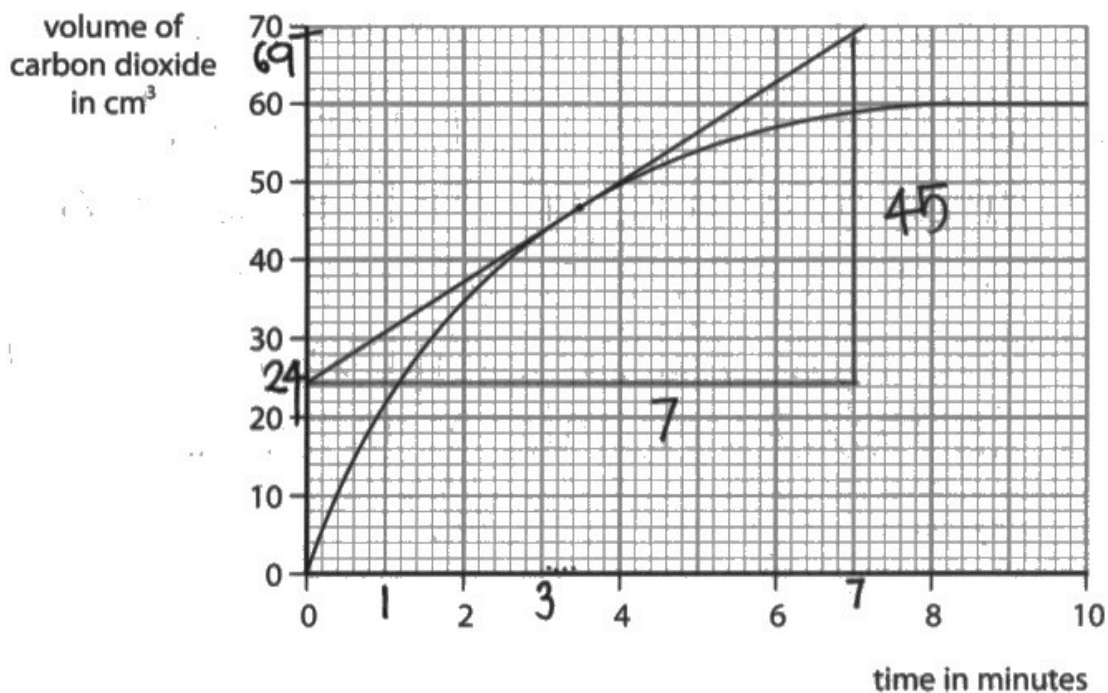


Figure 4

(i) State the total volume of carbon dioxide produced in the first 3.5 minutes.

(1)

$$69 - 24 =$$

volume = 45 cm<sup>3</sup>



**ResultsPlus**  
Examiner Comments

This candidate has placed a dot in the correct place, but unfortunately has not read the scale carefully enough. They have also shown on their graph the working for the next part.

## Question 2 (b)(ii)

A range of answers were seen here, largely due to the varying degrees of rounding that took place throughout the calculation. Many candidates were clearly using very small tangents (if a tangent at all) to calculate the gradient – as the dy and dx values were very small, which led to a large degree of error. Some rounding was incorrect, and often it was given to the nearest whole number.

- (ii) Using the tangent, calculate the rate of reaction at 3.5 minutes in  $\text{cm}^3$  per minute.

$$\text{rate of reaction} = \frac{\text{change in gas volume}}{\text{change in time}} \quad (3)$$

$$7.0 - 2.5 = 4.5 \text{ (change in gas volume)}$$

$$~~3.5 - 0 = 3.5 \text{ (change in time)}~~$$

$$(7.1 - 0) = 7.1 \text{ (change in time)}$$

$$\frac{4.5}{7.1} = 6.338$$

$$6.3 \quad \checkmark$$

$$\text{rate} = 6.3 \text{ cm}^3 \text{ per minute}$$



**ResultsPlus**  
Examiner Comments

The working is shown clearly here and the final value is correctly rounded.



**ResultsPlus**  
Examiner Tip

Show your working clearly in all calculations.

- (ii) Using the tangent, calculate the rate of reaction at 3.5 minutes in  $\text{cm}^3$  per minute.

$$\text{rate of reaction} = \frac{\text{change in gas volume}}{\text{change in time}}$$

44

(3)

3.5

$$\text{rate} = 12.57 \text{ cm}^3 \text{ per minute}$$



**ResultsPlus**  
Examiner Comments

This candidate has divided by the time at which the rate is being calculated, not the change in time.

## Question 2 (c)

Generally this was well answered with almost all saying that the rate increased, and the majority of candidates able to make the correct link between surface area and rate, with the most popular explanation being linked to bigger surface area. More collisions was a common error for the explanation, which didn't score, and candidates who went down this route did not often refer to the frequency of collisions. Only a few made the error to say that the surface area was smaller as the size of the marble chips decreased.

(c) The student repeats the experiment using the same mass of smaller marble chips.

All other conditions remain the same.

Explain the effect on the rate of reaction of using smaller marble chips.

(2)

The rate of reaction increases as more frequent collisions occur. Smaller particles increase the ~~SA~~ surface area making the reaction faster.



A good answer saying that the rate increases ('faster') due to a higher surface area with therefore more frequent collisions.

(c) The student repeats the experiment using the same mass of smaller marble chips.

All other conditions remain the same.

Explain the effect on the rate of reaction of using smaller marble chips.

(2)

The effect on the rate of reaction of using smaller marble chips would be faster and more  $\text{CO}_2$  gas would be produced faster each minute as it would take less time for the reaction to occur due to the marble chips being smaller.



**ResultsPlus**  
Examiner Comments

This answer states that the reaction is faster but does not give a scientific reason why.

### Question 3 (a)

Most candidates knew this test, but some did not use the phrase '**glowing** splint' which was required. Some described the process, such as 'get a lit splint and blow it out', but did not mention that the splint was then a glowing splint, or described 'embers'. Others said that 'a lit splint will relight', or gave the test for hydrogen or carbon dioxide.

### Question 3 (b)

The majority of candidates calculated this correctly, using the method of  $50.000 - (0.529 \times 2)$ . There were varying degrees of rounding, most of which was done correctly. The most common error was  $50.000 - 4.200 = 45.8$ .

### Question 3 (c)(i)

Many candidates answered this question well, with most scoring the first mark, knowing that the atoms have full outer shells. Common errors included the failure to use the word 'electrons' in their response (asked for in the question) (eg 'does not need to lose or gain', 'they do not need to react'), not mentioning the **outer** shell or referring to the outer shell having 8 electrons rather than being full (not true for Helium), or the outer shell being empty.

(c) Helium, neon and argon are all inert.

(i) Explain, in terms of electrons, why these gases are inert.

(2)

They have a full outer shell with 8 electrons, so they are unreactive as no electrons can be lost or gained



**ResultsPlus**  
Examiner Comments

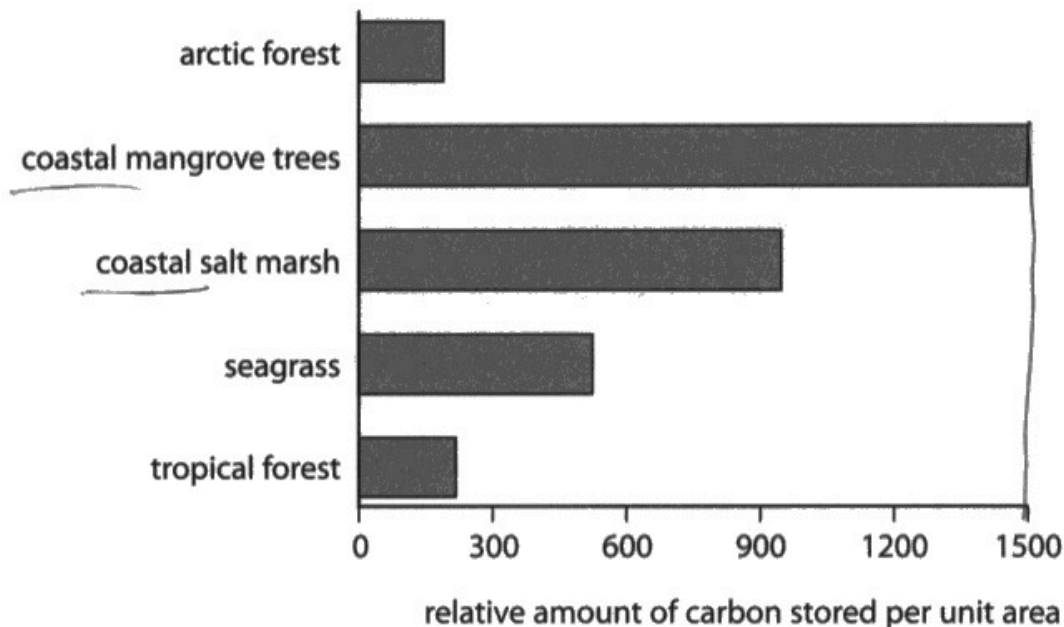
This answer is in terms of electrons but is careless – helium atoms do not have 8 electrons in their outer shell.

### Question 3 (d)

Most candidates gained the first mark, recognising that coastal ecosystems stored more carbon, however the second mark was less commonly awarded. The question said 'Describe how the data... ' but many did not use data at all, or just quoted directly from the table, with no deduction made from it. Candidates should be encouraged to use the figures (not just copy them out) when they are given a data analysis question – it is likely that full marks will not be available without this being included.

- (d) Carbon dioxide is removed from the atmosphere by plants and stored in plants and soil as carbon compounds.

Figure 5 shows the relative amounts of carbon stored in plants and soils in different environments.



**Figure 5**

It has been suggested that preserving coastal ecosystems is more effective than reforestation in the mitigation of climate change.

Describe how the data in Figure 5 supports this suggestion.

(2)  
The coastal mangrove trees store 1500 carbon per unit area whereas tropical and arctic forests are all below 300 per unit. Both coastal ecosystems have more carbon stored per unit than reforestation.  
(Total for Question 3 = 9 marks)



This candidate has tried to use the data, but has only picked out the data for one of the coastal habitats (even though they underlined both in the table). They have however reached the correct conclusion.

- (d) Carbon dioxide is removed from the atmosphere by plants and stored in plants and soil as carbon compounds.

Figure 5 shows the relative amounts of carbon stored in plants and soils in different environments.

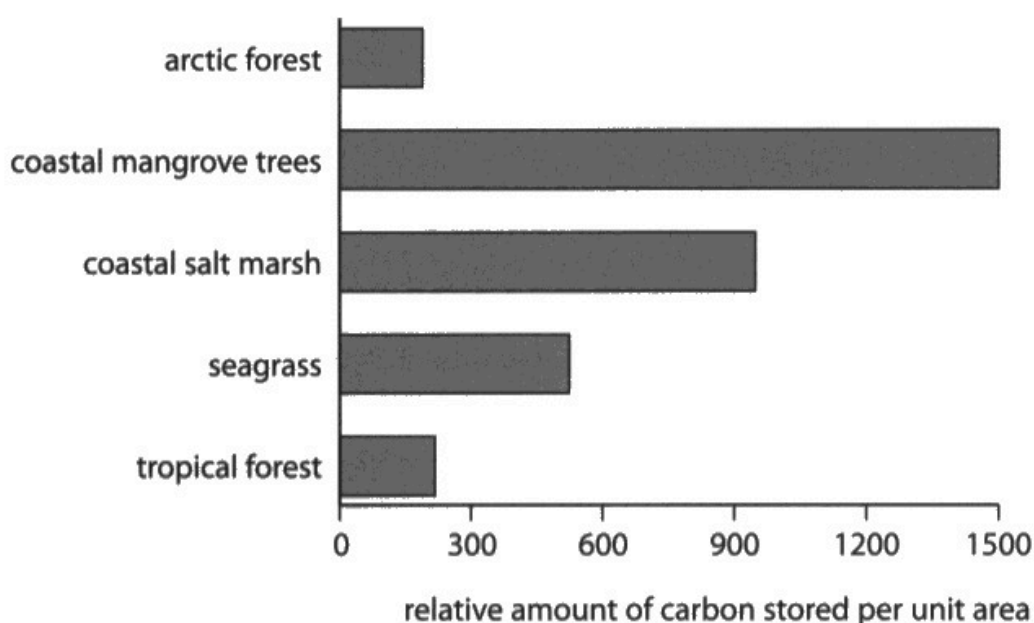


Figure 5

It has been suggested that preserving coastal ecosystems is more effective than reforestation in the mitigation of climate change.

Describe how the data in Figure 5 supports this suggestion.

(2)

Figure 5 shows that there are way more carbon stored in coastal ecosystems such as mangrove trees, salt marshes and seagrass compared to forests like the arctic and tropical forest. Therefore more carbon is protected from being released.

(Total for Question 3 = 9 marks)



This answer has made a correct comparison but has not used any data.



Where data is provided, candidates should make numerical comparisons.

## Question 4 (a)(i)

This question was well answered with gloves and goggles the most common responses. Where marks were lost, 'corrosive' was not always correct – for example irritant or corroding, and some listed multiple hazards. Some candidates list lots of generic PPE, or not getting on hands etc. They should be reminded that glasses alone is not sufficient, it has to be goggles or safety glasses.

- 4 (a) Figure 6 shows a poly(ethene) bottle containing substance K with one of its hazard symbols showing.

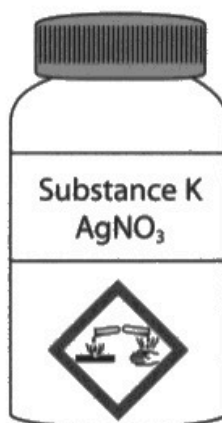


Figure 6

- (i) Explain a safety precaution that should be taken when using a substance with the hazard symbol shown in Figure 6.

(2)

Gloves should be worn when using a substance with this hazard symbol because it shows the substance is corrosive and could damage the skin.



This is a good answer which has identified the hazard symbol – corrosive – and has given a precaution.

- 4 (a) Figure 6 shows a poly(ethene) bottle containing substance **K** with one of its hazard symbols showing.

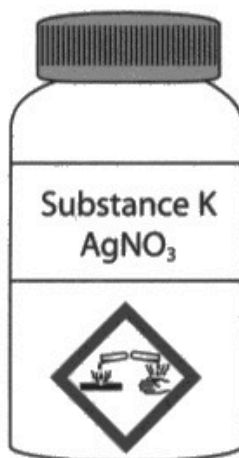


Figure 6

- (i) Explain a safety precaution that should be taken when using a substance with the hazard symbol shown in Figure 6.

(2)

If substance touches the skin, wash hands immediately after contact.



This answer does not score. The hazard symbol has not been identified and the precaution is too generic.

### Question 4 (a)(ii)

Most candidates could successfully name silver nitrate.

### **Question 4 (a)(iii)**

This question was well done, with inert and unreactive common answers, but candidates should be reminded to link the property to the use given in the question, rather than general uses. Common incorrect responses included strong, durable, flexible and non-corrosive.

## Question 4 (a)(iv)

Many candidates scored for using nitric acid, perhaps because they had learned this. Many fewer were able to explain why HCl was not appropriate (sadly, some said that HCl contained chlorine, rather than chloride ions). Errors included hydrochloric acid would not be effective at removing carbonate impurities or the test would not work without nitric acid. Others suggested that they had to alter the concentration of the acid (often to use concentrated acid), measure the volume of the acid (rather than 'add some'), or use an excess of acid.

(iv) A student tests a solid for chloride ions.

The student uses the following method.

**step 1** dissolve a small amount of the solid in water

**step 2** add some dilute hydrochloric acid

**step 3** add a few drops of a solution of K

**step 4** observe whether or not a white precipitate forms.

This method to show whether the solid contains chloride ions will not work.

Explain a change that needs to be made to **step 2** to allow this method to work.

(2)

- add a higher concentration of dilute hydrochloric acid.  
- so that it is in excess and can react completely.



A common error was to alter the amount or concentration of HCl.

(iv) A student tests a solid for chloride ions.

The student uses the following method.

**step 1** dissolve a small amount of the solid in water

**step 2** add some dilute hydrochloric acid

**step 3** add a few drops of a solution of K

**step 4** observe whether or not a white precipitate forms.

This method to show whether the solid contains chloride ions will not work.

Explain a change that needs to be made to **step 2** to allow this method to work.

(2)

Use a different acid like  
nitric acid as HCl  
already contains chlorine  
meaning it's an inaccurate test



The candidate has identified correctly to use nitric acid, but unfortunately it is the chloride ions – not chlorine – that is important.



Refer carefully to species – chlorine (atoms or molecules) is not the same as chloride (ions).

(iv) A student tests a solid for chloride ions.

The student uses the following method.

**step 1** dissolve a small amount of the solid in water

**step 2** add some dilute hydrochloric acid

**step 3** add a few drops of a solution of K

**step 4** observe whether or not a white precipitate forms.

This method to show whether the solid contains chloride ions will not work.

Explain a change that needs to be made to **step 2** to allow this method to work.

(2)

It should be ~~nitrate~~ not be hydrochloric acid ~~as~~ as it already has chloride in it so will be an unfair test.



**ResultsPlus**  
Examiner Comments

This candidate has spotted the problem, but not suggested an alternative acid.

## Question 4 (b)

Not many candidates scored full marks, although those who had the correct formulae often also scored the balancing mark. Incorrect products included H<sub>2</sub>O being replaced by H<sub>2</sub> or H<sub>3</sub>O; CO<sub>2</sub> being replaced with CO<sub>3</sub>; NaCl<sub>2</sub>, Na<sub>2</sub>Cl<sub>2</sub>, Na<sub>2</sub>Cl or Na<sub>2</sub>Cl f or NaCl. Others even added in atoms that were not present in the reactants, or gave HCl as a product and reactant. An incorrect formula for sodium chloride was the most common error.

(b) In the test for carbonate ions, the carbonate ions react with an acid.

Sodium carbonate, Na<sub>2</sub>CO<sub>3</sub>, is reacted with dilute hydrochloric acid.

Complete and balance the equation for this reaction.

(3)



Symbol equations cannot be completed with words.

(b) In the test for carbonate ions, the carbonate ions react with an acid.

Sodium carbonate, Na<sub>2</sub>CO<sub>3</sub>, is reacted with dilute hydrochloric acid.

Complete and balance the equation for this reaction.

(3)



The formulae and balancing are correct. The candidate has been very careless with the size and case of the letters (L in NaCl is capital, O in CO<sub>2</sub> is too small) and in subscripts (neither look like subscripts). Luckily for this candidate, this aspect of formulae was tested in another question in this paper. If the use of capital/small letters and subscripts/superscripts had been tested here, this would not have achieved full marks.

(b) In the test for carbonate ions, the carbonate ions react with an acid.

Sodium carbonate,  $\text{Na}_2\text{CO}_3$ , is reacted with dilute hydrochloric acid.

Complete and balance the equation for this reaction.

(3)



**ResultsPlus**  
Examiner Comments

Incorrect formulae were not uncommon.

### Question 4 (c)

Most candidates handled this question well, with the most common error being not to divide by 2, giving a final answer of 170 and scoring 1 mark.

- (c) The carbonate of element X has the formula  $X_2CO_3$ .  
The relative formula mass of this carbonate is 230.

Using this information, calculate the relative atomic mass of X.

(relative atomic masses: C = 12, O = 16)

(2)

$$(2x) + 12 + (3 \times 16) = 230 \quad x = 85$$

$$2x + 60 = 230$$

$$2x = 170$$

relative atomic mass of X = 85

**(Total for Question 4 = 11 marks)**



It's good to see such clear working.

- (c) The carbonate of element X has the formula  $X_2CO_3$ .  
The relative formula mass of this carbonate is 230.

Using this information, calculate the relative atomic mass of X.

(relative atomic masses: C = 12, O = 16)

$$12 + (16 \times 3)$$

$$12 + 48 + X \quad X_2 = 230$$

$$60 + X \quad X_2 = 230$$

$$\sqrt{230} \div 60 \downarrow$$

$$1.957890021$$

✓

(2)

relative atomic mass of X = 2

**(Total for Question 4 = 11 marks)**



**ResultsPlus**  
Examiner Comments

A misunderstanding of  $X_2$  seen here.

## Question 5 (a)(i)

Where candidates answered well they often gave the same functional group and the same general formula as their two points. However, there was a lot of imprecision or confusion. Examples included: same chemical properties (not similar), trend in chemical properties, similar physical properties (not a trend), same properties, same empirical formula, same molecular formula, same formula, same structural formula, same structure, same displayed formula, same group. There were a worrying number of answers which referred to the definition of a hydrocarbon – for example, all contain carbon and hydrogen.

- 5 (a) (i) Most hydrocarbons found in fossil fuels are members of the alkane homologous series.

State **two** features of an homologous series.

(2)

1 Similar properties

2 The same general formula



Similar properties is not acceptable – chemical properties are similar, but physical properties are not, showing a trend.

- 5 (a) (i) Most hydrocarbons found in fossil fuels are members of the alkane homologous series.

State **two** features of an homologous series.

(2)

1 members in a the same homologous series have the same general formula

2 members of the same homologous series have similar chemical properties



This candidate, however, has correctly stated similar chemical properties.

## Question 5 (b)

This question was generally answered well, although not all candidates stated that  $\text{CO}_2$  and  $\text{SO}_2$  were formed. Some candidates talked about carbon and sulfur being the pollutants (eg 'carbon causes global warming'), or sulfur oxide. Others only discussed one of the gases, usually carbon dioxide. Lots of candidates knew the issues – global warming and acid rain – but these had to be linked to the relevant gases to score. Some referred to the production of CO and the hazards associated, presumably not reading the complete combustion part of the question. Some candidates think that carbon dioxide destroys the ozone layer which leads to global warming.

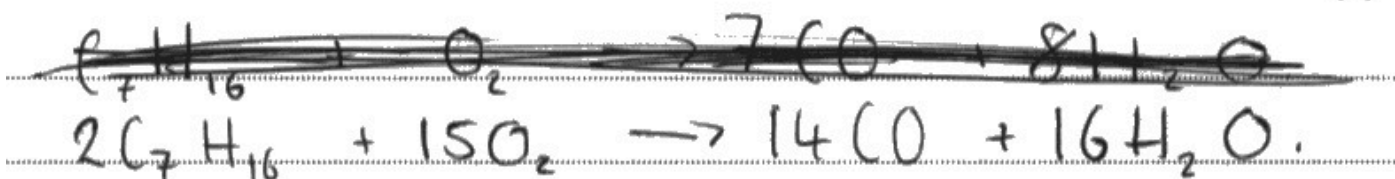
### Question 5 (c)

Despite the question's wording, many equations had CO<sub>2</sub> or C as products. Some had H<sub>2</sub> as a product, or used O as a reactant. Of those that did get the correct equation, balancing could be a challenge. A common error was to round the 7.5 O<sub>2</sub> up or down to give a whole number.

(c) Incomplete combustion of fuels may produce carbon monoxide.

Write the balanced equation for the incomplete combustion of heptane, C<sub>7</sub>H<sub>16</sub>, where all of the carbon atoms form carbon monoxide.

(2)



(Total for Question 5 = 9 marks)



C - 14  
H - 32  
O - 30

C - 14  
H - 30  
O - 14



**ResultsPlus**  
Examiner Comments

Correct equation.



**ResultsPlus**  
Examiner Tip

The candidate has worked out how many atoms of each element are on each side of the equation which is a good method/ check.

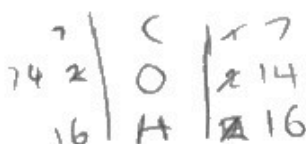
(c) Incomplete combustion of fuels may produce carbon monoxide.

Write the balanced equation for the incomplete combustion of heptane,  $C_7H_{16}$ , where all of the carbon atoms form carbon monoxide.

(2)



(Total for Question 5 = 9 marks)



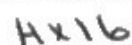
**ResultsPlus**  
Examiner Comments

Perhaps the candidate did not read the question carefully enough, but both products incorrect here. There are no marks for balancing incorrect products.

(c) Incomplete combustion of fuels may produce carbon monoxide.

Write the balanced equation for the incomplete combustion of heptane,  $C_7H_{16}$ , where all of the carbon atoms form carbon monoxide.

(2)



(Total for Question 5 = 9 marks)



Again, this candidate has not followed the instructions and has included C as a product.

## Question 6 (a)(ii)

Most candidates who scored achieved the mark for leaving the experiment for longer, and often then went on to talk about repeating readings until they did not change. Another correct answer was to 'add more iron wool', although fewer here went on to score the second marking point for saying that this would mean the iron was then in excess. Others did not get the point and tried to test for oxygen, or to add a gas syringe to measure the oxygen. Some considered this to be a rates of reaction question, commenting that the iron should be heated to ensure it reacted with the oxygen faster, or even added a catalyst.

- (ii) Describe **one** improvement the student could make to this method to ensure that all of the oxygen in the measuring cylinder has reacted.

(2)

Leave the measuring cylinder for longer until the volume of gas stays the same / stays constant as this means no more reaction is taking place so all of the oxygen has reacted.



**ResultsPlus**  
Examiner Comments

A good explanation of why leaving the experiment for longer would work.

- (ii) Describe **one** improvement the student could make to this method to ensure that all of the oxygen in the measuring cylinder has reacted.

(2)

The student could add the damp iron wool in excess to ensure all of the oxygen ~~has reacted~~ in the measuring cylinder has reacted.



**ResultsPlus**  
Examiner Comments

This was the second approach to answering the question.

## Question 6 (b)(i)

Most candidates did not carefully look at the apparatus and say, as asked, what needs to be done to this apparatus. Many wanted to add a condenser to collect the water and to add an additional test tube containing limewater to the end of the apparatus. In other words, many seemed to know what needed to happen but struggled to apply this to adjusting the apparatus in the question. Some were not specific enough – ‘add limewater’ or ‘test with limewater’ but not saying where (tube B).

(b) (i) When hydrocarbon fuels are burned, the products are water and carbon dioxide.

Describe what needs to be done to the apparatus in Figure 8 to collect the water and show that carbon dioxide has been produced.

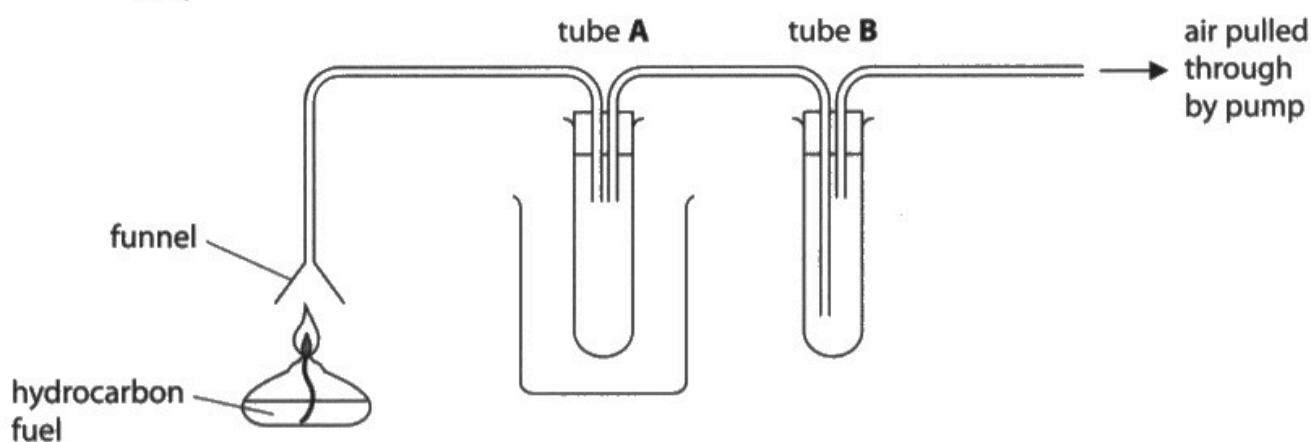


Figure 8

(2)

- fill beaker around tube A with cold water and the  $H_2O$  in tube A will condense and increase volume
- to fill tube B with lime water and it should turn cloudy



**ResultsPlus**  
Examiner Comments

A well explained answer using the apparatus.

- (b) (i) When hydrocarbon fuels are burned, the products are water and carbon dioxide.

Describe what needs to be done to the apparatus in Figure 8 to collect the water and show that carbon dioxide has been produced.

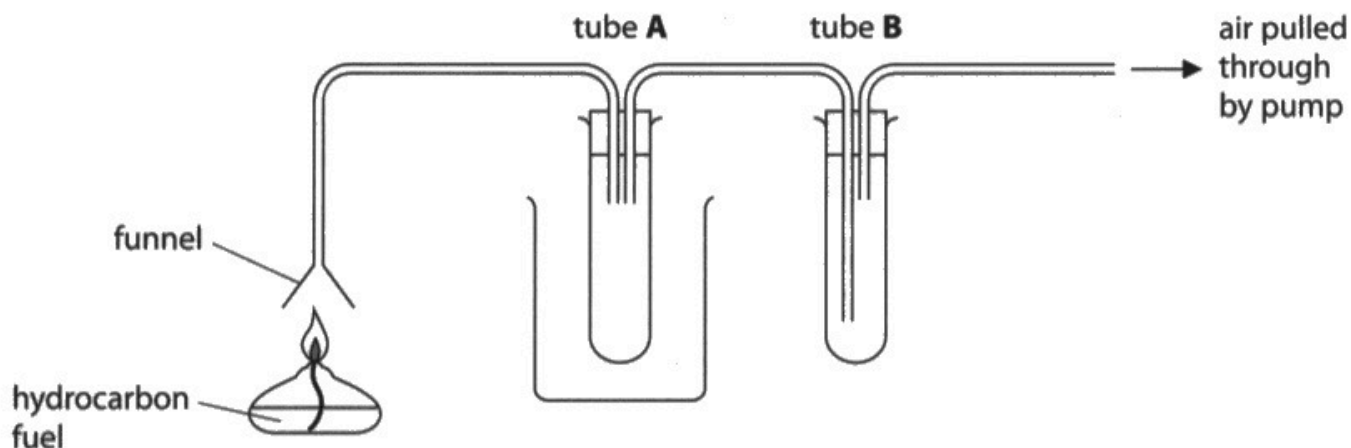


Figure 8

(2)

- Put a condenser just before tube A to turn water vapour back into a liquid
- Put lime water in tube B, if it turns cloudy the  $\text{CO}_2$  is present.



**ResultsPlus**  
Examiner Comments

A common error – to add a condenser – but this was not required.

## Question 6 (b)(ii)

The better candidates scored all the marks, and most candidates were able to score some – it is important to emphasise that clear working allows part-marks to be awarded. The moles of carbon/carbon dioxide were calculated correctly very often. Many went on to calculate the moles of water (0.3), but did not realise that this was not the same as the moles of hydrogen atoms (0.6). But many of these at least produced a ratio, though often 2:1 not 1:1. Some candidates with an incorrect ratio at least worked out that this was not consistent with 78, and the final mark was awarded for the correct formula even if this was worked out in another way. On the other hand, some did not check that the formula they produced had a Mr of 78. (However, for all 4 marks the data in the question had to be used to derive the formula).

- (ii) A hydrocarbon,  $C_xH_y$ , is burned in excess oxygen, forming 26.4 g of carbon dioxide and 5.4 g of water.

The relative formula mass of  $C_xH_y$  is 78.

Calculate the molecular formula of the hydrocarbon  $C_xH_y$ .

(relative atomic masses: H = 1.0, C = 12;  
relative formula masses:  $H_2O = 18$ ,  $CO_2 = 44$ )

(4)

$$26.4 + 5.4 = 31.8$$

$$\frac{26.4}{44} = 0.6 \quad \frac{5.4}{18} = 0.3$$

molecular formula = .....

**(Total for Question 6 = 9 marks)**



Although this candidate did not know how to answer the question, they wisely calculated the moles which scored 1 mark.

- (ii) A hydrocarbon,  $C_xH_y$ , is burned in excess oxygen, forming 26.4 g of carbon dioxide and 5.4 g of water.

The relative formula mass of  $C_xH_y$  is 78.

Calculate the molecular formula of the hydrocarbon  $C_xH_y$ .

(relative atomic masses: H = 1.0, C = 12;  
relative formula masses:  $H_2O = 18$ ,  $CO_2 = 44$ )

(4)

molecular formula =  $C_6H_6$

**(Total for Question 6 = 9 marks)**



Although this candidate has  $C_6H_6$  – although not clearly written – they only scored 1 mark because no working was shown.

## Question 7 (a)

Whilst some candidates gave the general answer to this question, most focussed specifically on potassium and argon. Some answered properly in terms of protons, whilst others tried to give electronic configuration-based answers, talking about the number of shells or the total electrons in potassium compared to argon. Some mentioned the groups they were in, or their reactivity.

- 7 (a) The relative atomic mass of argon is 40 and the relative atomic mass of potassium is 39 but potassium appears after argon in the periodic table.

State why potassium appears after argon in the periodic table.

(1)

because potassium is in group 1  
and Argon is in group 0



A not uncommon error.

### Question 7 (b)(i)

This was surprisingly poorly answered. Many candidates gave names rather than formulae which were required. For many, neither product was correct. Incorrect products included oxygen (or even carbon dioxide), and unfortunately H, and  $K_2O$ , KO or  $KO_2$  instead of KOH.

(b) Potassium reacts with water to form two products.

(i) Give the formulae of both products.

(1)

..... ~~2K~~ KOH and ..... ~~2K~~ H .....



**ResultsPlus**  
Examiner Comments

The use of an atom instead of a diatomic molecule for gas elements and halogens is a common error in questions like this and in equations.

### Question 7 (b)(ii)

An exothermic reaction profile diagram was often given, but incorrect placement of activation energy was quite common (and even when an endothermic graph was shown, the activation energy was also rarely shown correctly). Where the candidates seemed to know what to draw, the next hurdle that caught many out was imprecise arrows for the activation energy, which just sat vaguely in the middle of the energy peak, or didn't go to the highest point.

(ii) The reaction of potassium with water is exothermic.

On Figure 9, draw and label the reaction profile diagram for this reaction, labelling the activation energy.

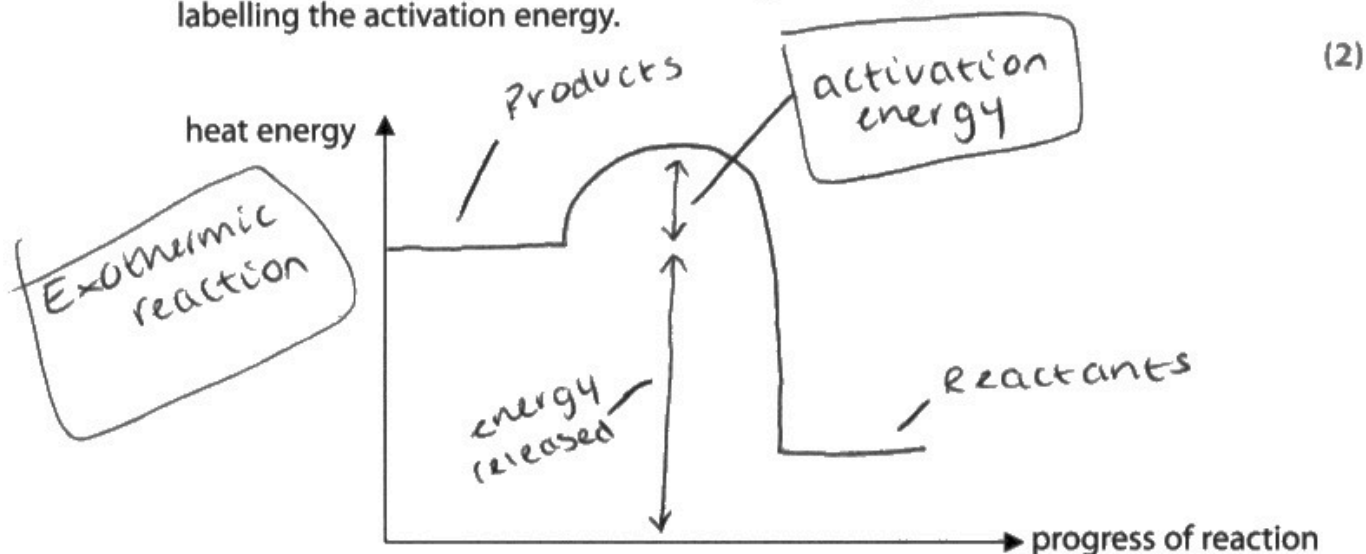


Figure 9



The correct basic shape – but reactants and products are reversed.

(ii) The reaction of potassium with water is exothermic.

On Figure 9, draw and label the reaction profile diagram for this reaction, labelling the activation energy.

(2)

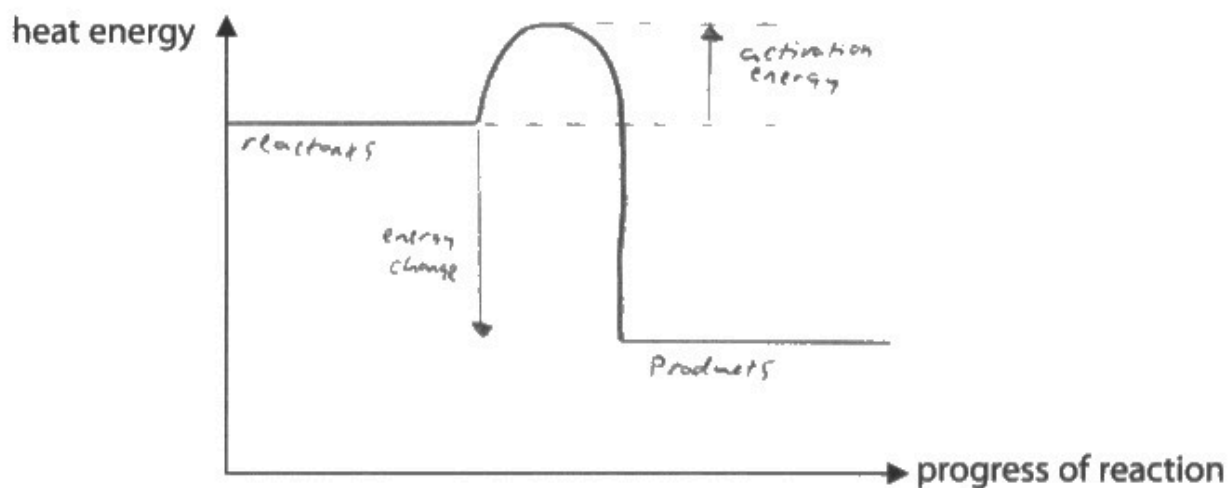


Figure 9



**ResultsPlus**  
Examiner Comments

The activation energy is clearly shown in this example.

## Question 7 (c)

Most candidates knew that bond breaking requires energy/ is endothermic. However, a common error was to consider that both breaking and making bonds required energy to be taken in. Unfortunately, relatively few answers included the idea that bond formation is exothermic. Many candidates simply defined endothermic without relating this to bonds.

(c) Some reactions are endothermic.

Explain, in terms of bond breaking and bond forming, why some reactions are endothermic.

(3)

For a reaction to be endothermic it means that more energy is used when forming bonds than energy released when bonds are broken. Meaning that energy needs to be taken in from surroundings.



An example of where the energy changes are back to front.

(c) Some reactions are endothermic.

Explain, in terms of bond breaking and bond forming, why some reactions are endothermic.

(3)

In endothermic reactions heat/energy is absorbed.

So when bonds are ~~form~~ broken energy is

absorbed in making it endothermic, but bonds

forming releases energy which is exothermic

the opposite of endothermic.



**ResultsPlus**  
Examiner Comments

The energy terms are correct, but this answer does not explain why, overall, the reaction is endothermic.

## Question 7 (d)

Candidates had a good grasp of this process (perhaps surprisingly given the response to the previous part). Even where the final answer was incorrect, many candidates calculated +55 which scored 3 marks; this error was subtracting the bonds broken from the bonds made. It is very helpful when candidates show clear working so that, in cases where an error was made in the bond energies broken and/or made, part marks can still be awarded if the working can be followed. Errors were mainly due to miscounting the numbers of each bond, or not including the H-Cl bond.

(d) Ethene reacts with hydrogen chloride.

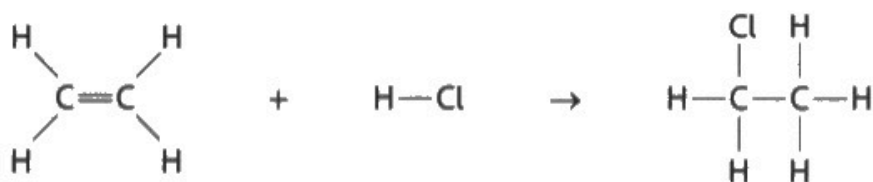


Figure 10 shows the bond energies for the different bonds in the three molecules in the reaction.

bond	bond energy in $\text{kJ mol}^{-1}$
C—H	412
C=C	612
C—C	348
H—Cl	431
C—Cl	338

Figure 10

Calculate the energy change for this reaction.

(4)

$$412 \times 4 = 1648$$

$$412 \times 5 = 2060$$

$$612 \times 1 = 612$$

$$348 \times 1 = 348$$

$$431 \times 1 = 431$$

$$338 \times 1 = 338$$

$$\underline{2691}$$

$$\underline{2746}$$

$$\begin{array}{r} 61 \\ 2746 \\ - 2691 \\ \hline 0055 \end{array}$$

energy change = 55  $\text{kJ mol}^{-1}$

(Total for Question 7 = 11 marks)



The working is clearly laid out. Unfortunately, the subtraction has been reversed.

(d) Ethene reacts with hydrogen chloride.

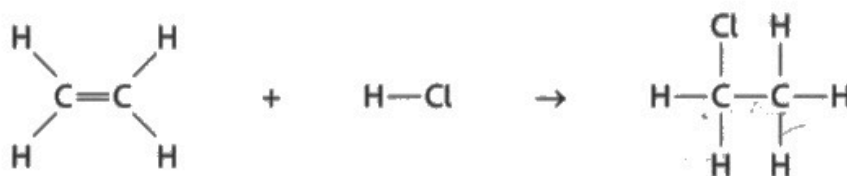


Figure 10 shows the bond energies for the different bonds in the three molecules in the reaction.

bond	bond energy in $\text{kJ mol}^{-1}$
C—H	412
C=C	612
C—C	348
H—Cl	431
C—Cl	338

Figure 10

Calculate the energy change for this reaction.

(4)

$$\text{C}_2\text{H}_4 = 612 + (412 \times 4) = 2260$$

$$\text{HCl} = 431 \times 1 = 431$$

$$\text{Total for reactants} = 2691$$

$$\text{C}_2\text{H}_5\text{Cl} = 348 + (412 \times 5) + 338 = 2746$$

$$\text{Total for products} = 2746$$

$$2691 - 2746 = -55$$

$$\text{energy change} = -55 \text{ kJ mol}^{-1}$$

(Total for Question 7 = 11 marks)



Perfectly laid out, and fully correct.

## Question 8 (a)(i)

There were some excellent answers here where candidates knew the test and hence understood why the conclusion may not be correct. Others did not seem to have read the question and understand that there were only three possibilities. A lot of candidates said to add excess NaOH to confirm it is aluminium sulfate, rather than aluminium ions (when of course it could be aluminium chloride). Some candidates who realised that it 'could be sulfate/chloride ions', often did not go on to say that no anion test was carried out.

**8 (a)** A solid is known to be either aluminium chloride or aluminium sulfate or calcium chloride.

A few drops of sodium hydroxide solution are added to a solution of the solid and the mixture is shaken.

A white precipitate is seen.

A student concludes that the solid is aluminium sulfate.

(i) Explain why this conclusion may not be correct.

(2)

• Because both aluminium and calcium make white precipitates

• This means it could be any of these 3 solids.



This candidate has understood the point of the question, although aluminium ions and calcium ions would have been better.

## Question 8 (a)(ii)

For a straightforward test, this was not as well answered as one would expect. When candidates did identify barium chloride they also tended to gain the second mark for a white precipitate (although sadly some did not specify the colour of the precipitate or gave yellow as its colour). Common errors included adding barium sulfate instead of barium chloride (!), adding just barium, or using silver nitrate. There were quite a few responses that incorrectly referred to a flame test.

- (ii) Describe a test the student could use to confirm that the solid contains sulfate ions.

(2)

*A flame test, the colour should be yellow*



**ResultsPlus**  
Examiner Comments

Learning tests is important for Paper 2.

- (ii) Describe a test the student could use to confirm that the solid contains sulfate ions.

(2)

~~- Add barium chloride to the sulfate ions~~  
- Add hydrochloric acid to the solution.  
- Then add barium chloride solution.  
- Mix it and if a white precipitate is formed, <sup>there are</sup> sulfate ions.



**ResultsPlus**  
Examiner Comments

Giving the answer for a question like this in a bullet-point format is often a good idea.

## Question 8 (c)

The answers that were the most clear to follow made use of headings and clearly linked the observations to the reasoning and therefore the name of the substances. For R, the most common errors were stating that the lilac flame was potassium rather than the presence of potassium ions, or that R was potassium hydroxide. Most understood that S was an acid (many incorrectly identified S as hydrochloric acid), but fewer picked up that S had 2 carbon atoms and hence was ethanoic acid (some credit was given for S being a carboxylic acid).

Weaker candidates were able to score some marks for explanations about some of the observations. Many identified that Universal Indicator turning blue indicated alkali, and that orange indicated acid. The identification of carbon dioxide produced using limewater was common, though the fact that this meant a carbonate was rarely deduced. Overall, potassium carbonate was identified more often than ethanoic acid.

Some common chemical misconceptions were: blue UI test must mean  $\text{OH}^-$  ions are present, carbon dioxide gas comes from the carbons in ethanoic acid, a lilac flame test means potassium metal.

\*c) A technician has samples of two substances, **R** and **S**.

**R** is an ionic solid.

Molecules of **S** contain 2 carbon atoms.

The technician carries out some tests on **R** and on a solution of **S**.

The tests and the results obtained are shown in Figure 11.

test	result
add solid <b>R</b> to water and shake	the white solid dissolves to form a colourless solution
add universal indicator to the solution of <b>R</b>	indicator turned blue
flame test with solid <b>R</b>	lilac flame produced
appearance of solution of <b>S</b>	colourless
add universal indicator to solution of <b>S</b>	indicator turns orange
add a small piece of magnesium to solution of <b>S</b>	bubbles of gas released and magnesium disappears
add spatula measure of solid <b>R</b> to solution of <b>S</b>	bubbles of gas released that turn limewater cloudy solid <b>R</b> disappears

Figure 11

Identify **R** and **S**, using all of the data in Figure 11, explaining your reasoning from each test.

(6)

The white solid dissolves and forming the colourless solution suggests it is

The flame test of **R** gives lilac suggests it is ~~strontium~~ as an ion of copper.  
**R** is an acid as indicator went

S is an alkali so ~~water~~ indicator  
went orange

The gas produced when you  
add a spatula of ~~borax~~ K  
to solution of S is carbon  
dioxide as it turned lime water  
cloudy



**ResultsPlus**  
Examiner Comments

A Level 1 answer.

The candidate has attempted to deduce information but has only given a single correct piece of information on the second page, scoring 1 mark.

\*(c) A technician has samples of two substances, **R** and **S**.

**R** is an ionic solid.

Molecules of **S** contain 2 carbon atoms.

The technician carries out some tests on **R** and on a solution of **S**.

The tests and the results obtained are shown in Figure 11.

test	result
add solid <b>R</b> to water and shake	the white solid dissolves to form a colourless solution <i>Soluble</i>
add universal indicator to the solution of <b>R</b>	indicator turned blue <i>alkaline</i>
flame test with solid <b>R</b>	lilac flame produced <i>K</i>
appearance of solution of <b>S</b>	colourless
add universal indicator to solution of <b>S</b>	indicator turns orange <i>acidic</i>
add a small piece of magnesium to solution of <b>S</b>	bubbles of gas released and magnesium disappears <i>strongly</i>
add spatula measure of solid <b>R</b> to solution of <b>S</b>	bubbles of gas released that turn limewater cloudy solid <b>R</b> disappears <i>carbonate HCl</i>

Figure 11

Identify **R** and **S**, using all of the data in Figure 11, explaining your reasoning from each test.

**R** is potassium carbonate because potassium produces a lilac flame and it makes the limewater cloudy showing it's a carbonate. also it's alkaline (6)

**S** is Hydrochloric acid because it's colorless, orange indicator shows acidic, it forms bubbles of gas and dissolves magnesium it's used in the carbonate test.



A Level 2 answer.

Potassium carbonate has been correctly identified – although the justification for this is not fully explained. Some correct information is given about S – it is acidic – but nothing else that is correct.

\*(c) A technician has samples of two substances, **R** and **S**.

**R** is an ionic solid.

Molecules of **S** contain 2 carbon atoms.

The technician carries out some tests on **R** and on a solution of **S**.

The tests and the results obtained are shown in Figure 11.

*Potassium Carbonate Ethanoic Acid*

test	result
add solid <b>R</b> to water and shake	the white solid dissolves to form a colourless solution
add universal indicator to the solution of <b>R</b>	indicator turned blue <i>Alkaline</i>
flame test with solid <b>R</b>	lilac flame produced <i>Potassium</i>
appearance of solution of <b>S</b>	colourless
add universal indicator to solution of <b>S</b>	indicator turns orange <i>Acidic-ish</i>
add a small piece of magnesium to solution of <b>S</b>	bubbles of gas released and magnesium disappears <i>Acid</i>
add spatula measure of solid <b>R</b> to solution of <b>S</b>	bubbles of gas released that turn limewater cloudy <i>CO<sub>2</sub></i> solid <b>R</b> disappears

Figure 11

Identify **R** and **S**, using all of the data in Figure 11, explaining your reasoning from each test.

(6)

R

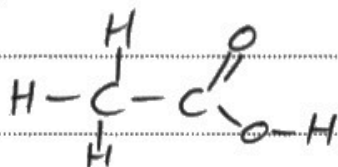
- It is a white ionic solid which dissolves in water to form colourless solution so is soluble
- This solution turns universal indicator blue ~~to~~ so is slightly alkaline (when the cation reacts with OH<sup>-</sup> ions in the water)
- It produces a lilac flame so cation is potassium
- Bubbles of gas formed from reaction with S turn limewater cloudy so gas is carbon dioxide

• Therefore R is Potassium Carbonate

S

- Colourless solution
- Turns universal indicator orange and reacts with metal until it disappears and (hydrogen) gas is released so it must be a dicarboxylic acid
- Solid R (potassium carbonate) disappears when they react together, confirming this
- It contains 2 carbon atoms and is an acid
- So S must be ethanoic acid
- Which is a colourless solution as this figure

$\text{CH}_3\text{COOH}$   ~~$\text{K}_2\text{CO}_3$~~  Ethanoic Acid S



$\text{K}_2\text{CO}_3$  Potassium Carbonate R



**ResultsPlus**  
Examiner Comments

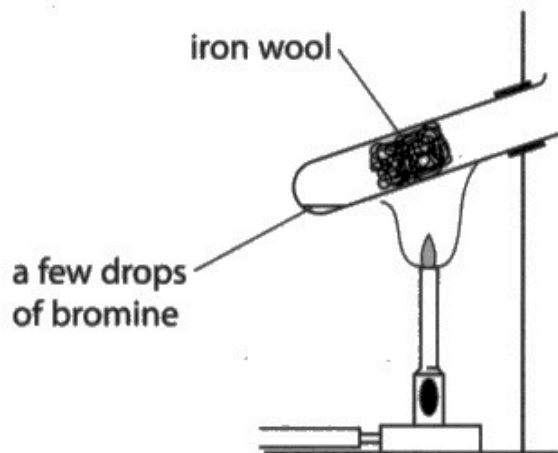
A Level 3 answer.

Both R and S have been identified with sufficient evidence for both identifications.

### Question 9 (b)

Most candidates identified iron bromide, although some just stated 'bromide'.

(b) Iron wool is heated with bromine vapour as shown in Figure 12.



**Figure 12**

At the end of the reaction, a solid forms at the top of the test tube.

Identify the solid.

(1)

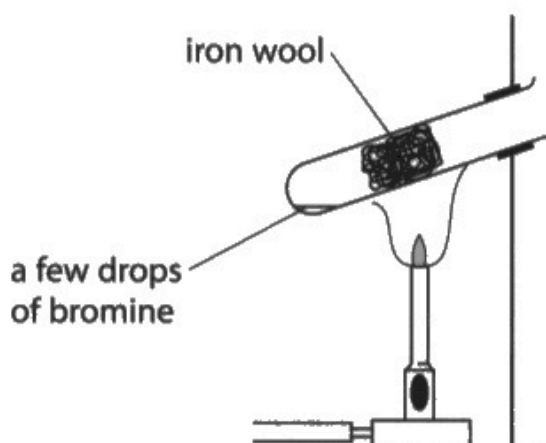
Bromide.



**ResultsPlus**  
Examiner Comments

The full name of the compound is required.

(b) Iron wool is heated with bromine vapour as shown in Figure 12.



**Figure 12**

At the end of the reaction, a solid forms at the top of the test tube.

Identify the solid.

(1)

Bromine Iron bromine



**ResultsPlus**  
Examiner Comments

'bromine' is not accepted for bromide.

### Question 9 (c)

Al was often given for aluminium, although Al<sub>2</sub> was seen. It was relatively common to give Br for bromine. If the reactant formulae were correct, 1 mark was scored. Multiple errors were seen in the formula for aluminium bromide. It was quite common to see AlBr, AlBr<sub>2</sub> or Al<sub>2</sub>Br<sub>3</sub>. Some candidates added incorrect charges to species.

(c) Aluminium reacts with bromine.

Write the balanced equation for the reaction between aluminium and bromine.

(3)

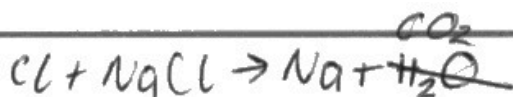
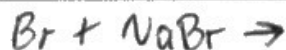


**ResultsPlus**  
Examiner Comments

Product formulae should be worked out using the Periodic Table.

## Question 9 (d)(i)

Most candidates were able to describe the combinations of reactants – many just mixing all halogens with all halides, but the very best describing just two reactions: chlorine + KBr and bromine + KI. One good way of showing the reactions and results was including a table which was populated with ticks and crosses. Unfortunately, some failed to record any results and were limited to 1 mark. Many candidates knew which pairs would react, however visual descriptions and colour changes were usually incorrect. The colour brown was seen fairly regularly for the colour of bromine – candidates should ensure that they learn orange/yellow for bromine and brown for iodine. Candidates should be careful to use – ine and – ide correctly in halogen questions. Equations were asked for, and word equations were often more accurate than symbol equations. Many candidates did know the order of reactivity, or gave a correct statement for the reactivity of halogens decreasing down the group.



\*(d) (i) The order of reactivity of the halogens can be found by displacement reactions.

A student was provided with

- solutions of bromine, chlorine and iodine
- solutions of sodium bromide, sodium chloride and sodium iodide.

Describe experiments the student could carry out using these solutions to find the order of reactivity of bromine, chlorine and iodine, explaining how the results would show the order of reactivity.

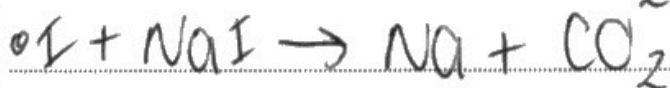
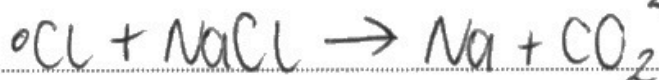
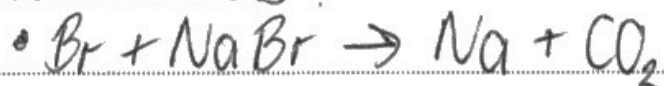
You should use equations to support your answer.

(6)

• Chlorine would be the most reactive as the shell electrons are the closest to the nucleus

• Bromine would be reactive but not as reactive as chlorine as its electrons are further away from the nucleus.

• Iodine would be the least reactive out of the three as its electrons are the furthest away from the nucleus.





A Level 1 answer.

The candidate knows the order of reactivity, for 1 mark, but has not given any experiments.

\*(d) (i) The order of reactivity of the halogens can be found by displacement reactions.

A student was provided with

- solutions of bromine, chlorine and iodine
- solutions of sodium bromide, sodium chloride and sodium iodide.

Describe experiments the student could carry out using these solutions to find the order of reactivity of bromine, chlorine and iodine, explaining how the results would show the order of reactivity.

You should use equations to support your answer.

(6)

You need to carry out halogen displacement reactions.

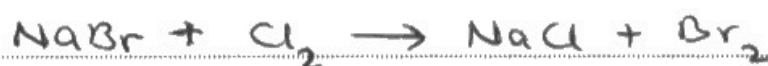
React each solution with the same volume of another solution.

For sodium bromide react it with chlorine & then iodine solution.

The less reactive halogen will be displaced from the compound, hence will observe changes during the reaction.

Iodine is the least reactive halogen hence will be displaced by bromine or chlorine.

Bromine is less reactive than chlorine.



A brown-orange colour will appear in the solution due to bromine forming.

Whichever element is displaced, is the less reactive than the other element.

Chlorine will remain in the compound of NaCl as neither bromine or iodine are more reactive.



A Level 2 answer.

The candidate has got the idea, but has not fully explained what to react with what. Some but not all results are given. The equation is incorrect, and the order of reactivity is not clearly stated in one sentence.

Na<sup>+</sup> Br<sup>-</sup>

- \* (d) (i) The order of reactivity of the halogens can be found by displacement reactions.

A student was provided with

- solutions of bromine, chlorine and iodine
- solutions of sodium bromide, sodium chloride and sodium iodide.

Describe experiments the student could carry out using these solutions to find the order of reactivity of bromine, chlorine and iodine, explaining how the results would show the order of reactivity.

You should use equations to support your answer.

(6)

### Method

- ~~measure out a small sample~~ add a few drops of halide salt solution to a ~~test tube~~ spotting tile
- add a few drops of halogen solution to test tube
- if there is a colour change, displacement has occurred.

### RESULTS

- chlorine can displace both bromide & iodide from their halide salt solutions.  
$$2\text{Cl} + 2\text{NaBr} \longrightarrow 2\text{NaCl} + \text{Br}_2$$
- bromine can displace both iodide from sodium iodide but not chlorine.  
$$2\text{Br} + 2\text{NaI} \longrightarrow 2\text{NaBr} + \text{I}_2$$
- iodide cannot displace the halogens from their halide salt solutions.

## REACTIVITY

- reactivity decreases down the group
- atomic radius gets larger
- halogens have  $7e^-$  in their outer shell
- only needs to gain 1 more to get a full outer shell.
- outer  $e^-$  is further away from nucleus
- less strongly attracted to nucleus
- becomes harder to gain that 1 electron.



A Level 3 answer.

The answer explains what reactions to carry out and what results would be given (although not perfectly expressed). The order of reactivity is given on page 2. There is no correct equation, so this was awarded 5 marks.

## Question 9 (d)(ii)

The worst aspect of this answer was that candidates did not always make it clear if they were referring to halogens or halides. Whilst many gave an indication that they knew what the word 'redox' meant, this was not applied to the context of the question. Where candidates scored 1 mark this was most often for the idea that halogens are reduced, and it was less common to see that the halide ion is oxidised (the halogen is oxidised was not uncommon). Candidates could have scored using half-equations but these were not regularly seen. Candidates might have benefitted in many cases from giving a sample equation and referring to the substances in their answer.

(ii) Explain why the displacement reactions of halogens are redox reactions.

(2)

This is because the halides are oxidised and lose electrons while the halogens are reduced and gain electrons

(Total for Question 9 = 13 marks)



**ResultsPlus**  
Examiner Comments

Perfectly expressed.

### Question 10 (a)(i)

Some candidates gave good answers here, the most common being the distance of the burner from the flask. Incorrect responses included start temperature of water, room temperature, volume of the alcohol, concentration of the alcohol, size of the flask or time of burning. Other answers were not specific enough eg distance of flask (from what?) or had imprecise use of apparatus names.

10 (a) Figure 13 shows the apparatus used to burn different alcohols.

The mass of each alcohol required to raise the temperature of the water by  $40^{\circ}\text{C}$  is found.

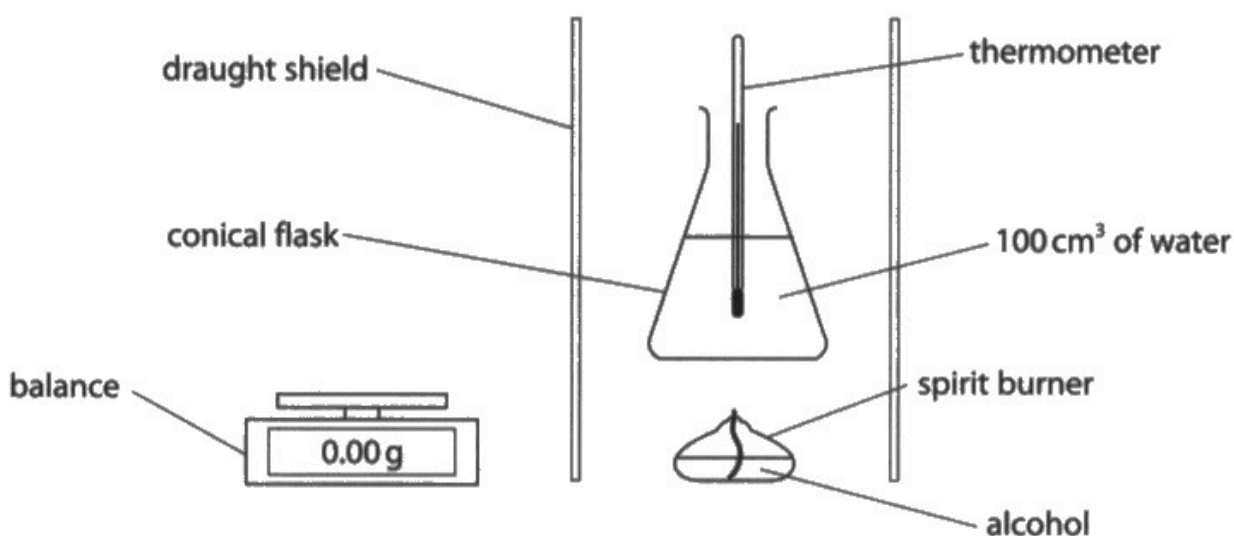


Figure 13

(i) State **one** variable, apart from the volume of water, that should be kept the same when each alcohol is burned.

(1)

*the distance between draught shield and conical flask.*



This would not be a critical factor in this experiment....

10 (a) Figure 13 shows the apparatus used to burn different alcohols.

The mass of each alcohol required to raise the temperature of the water by  $40^{\circ}\text{C}$  is found.

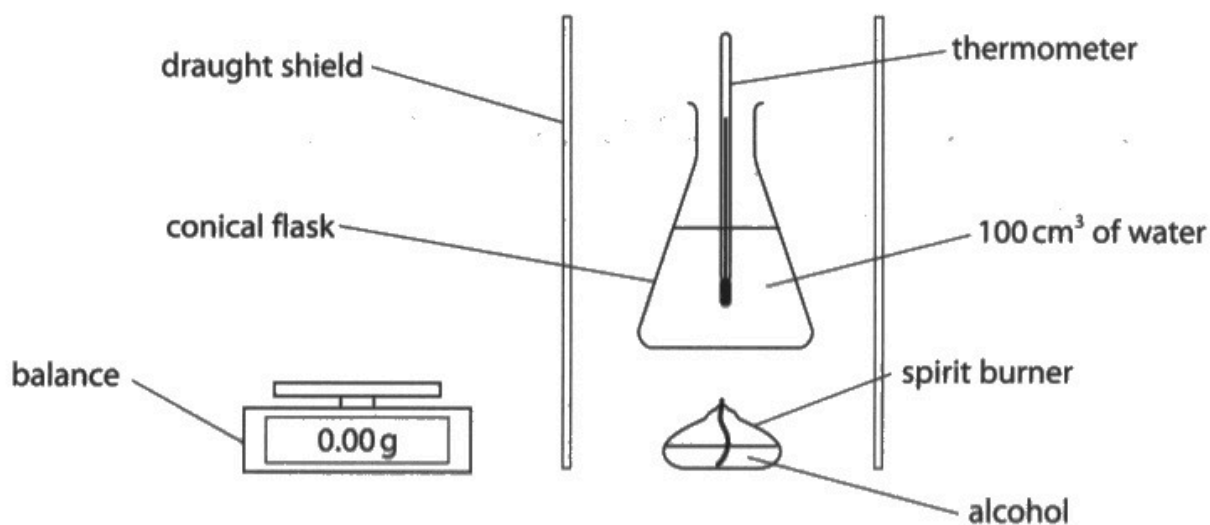


Figure 13

(i) State **one** variable, apart from the volume of water, that should be kept the same when each alcohol is burned.

(1)

The distance between burner + flask.



...but this would be.

### Question 10 (a)(ii)

Most candidates gained both marks for 0.035. Common errors included: the moles were multiplied by the Avogadro number or the mole calculation was inverted. Rounding and decimal errors were not uncommon in those who stumbled here, or transposition errors – writing 0.35 instead of 0.035, or not using 2 significant figures.

- (ii) It is found that 1.6 g of ethanol is used to raise the temperature of water by 40°C.

Calculate the number of moles of ethanol used.

Give your answer to two significant figures.

(relative formula mass: ethanol = 46)

(2)

$$\text{moles} = \text{mass} \div M_r$$

$$\text{moles} = \frac{1.6}{46} = 0.03478$$

$$46 = 0.035 \text{ 2 s.f.}$$

$$\text{number of moles} = 0.035$$



**ResultsPlus**  
Examiner Comments

A well set out and correctly rounded answer.

(ii) It is found that 1.6g of ethanol is used to raise the temperature of water by 40°C.

Calculate the number of moles of ethanol used.  
Give your answer to two significant figures.  
(relative formula mass: ethanol = 46)

(2)

$$\frac{1.6}{46} = 0.03$$

number of moles = 0.03



**ResultsPlus**  
Examiner Comments

Correct working – but the rounding is neither correct nor to 2 significant figures.

### Question 10 (a)(iii)

There was a good understanding of loss of heat to the surroundings seen in these answers. Incorrect responses referred to ethanol being lost (without linking it to evaporation), or being left behind in containers. Generic responses such as 'incomplete reaction' or 'side reactions' were seen occasionally which did not score.

(iii) The mass of ethanol used to raise the temperature of the water by 40 °C is higher than the theoretical value.

The experiment is repeated and the same result obtained.

Give a reason why the mass of ethanol used is higher than expected.

(1)

Some energy is lost to surroundings  
because it is not a closed system



Well expressed answer.

### Question 10 (b)(i)

A lot of confusion was seen here between the repeat unit and the monomer, where lots of the monomers did not have a double bond. 1 mark was allowed for the correct repeat unit, but 'n' was commonly written which caused a loss of this mark. Some opened up the phenyl ring and included it in the chain.

(phenylethene) is an addition polymer.



Figure 14 shows part of the poly(phenylethene) molecule formed in the addition reaction between three phenylethene monomer molecules.

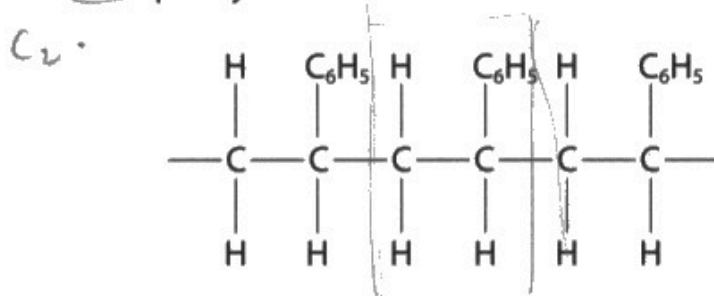
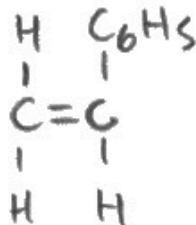


Figure 14

Draw the structure of **one** phenylethene monomer molecule.

(2)



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Examiner Comments

This is the correct answer and the lines show how the candidate worked it out.

## Question 10 (b)(ii)

Most candidates correctly gave an orange to colourless change (going colourless was very well known), although bromine's colour was sometimes identified as brown, and some candidates associated the orange colour with the alkene. The explanation (mark 3) was less well done, with the fact that the substance is an alkene most commonly referred to, which did not score, but the presence of a double bond often scoring the mark.

## Question 10 (c)

There was a large variation in answers here, mostly good. Most candidates were able to say that alkenes were monomers in addition; common answers for condensation were a carboxylic acid and an alcohol. It was less common to explore the idea of singular or multiple monomers. Some candidates missed the point of the question and gave an explanation of how the two different polymers formed rather than the monomers that made them up – there were a lot of references to only one product being formed in addition polymerisation and that there was water eliminated in a condensation polymerisation.

## Paper Summary

On the basis of the performance in this paper, candidates are advised to:

- learn how to draw common apparatus
- practise calculating the rate of reaction from a graph, using the largest possible tangent
- learn the chemical tests for gases and ions
- look at examples of questions where data is given and practise how to use the data
- understand how to work out simple formulae using the periodic table
- learn the products of the reaction between alkali metals and water
- practise drawing reaction profile diagrams
- in halide displacement reactions, learn how to refer to each species correctly
- practise drawing a monomer from the diagram of a polymer

## Grade boundaries

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

<https://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html>

