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Examiners' Report June 2022

GCSE Chemistry 1CH0 2H

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Introduction

Paper 2H is the second of two Chemistry papers for GCSE chemistry. There are ten questions on this paper, six of which make up the second chemistry paper in Combined Science. Questions two, three and four overlap with questions eight, nine and ten on the equivalent foundation chemistry paper.

This is the first set of summer GCSE examinations that have been sat since summer 2019. The papers were set and marked as usual, with this paper being targeted at grades 4 and above. The setting of grade boundaries was adjusted under Ofqual rules so that the standards were midway between 2019 and 2021.

An Advance Notice was issued giving some information about the topic areas that made up more than 5% of the total marks on the paper and those that would not appear across the two papers at all.

Most candidates attempted the majority of questions on the paper. The most able candidates showed a good mix of chemistry and practical knowledge as well as maths skills and were able to explain responses using the right scientific language.

Question 1 (a)(i)

This question was well answered overall, with the most common correct answers being related to the absorption/reflection of ultraviolet light or the fact that the particles are too small to be seen on the skin/have a large surface area to volume ratio.

When candidates did not score it was usually due to answers being too vague – for example referring to sunlight or rays rather than ultraviolet. Other responses were either incomplete (large surface area) or irrelevant (good insulator).

1 (a) Titanium dioxide nanoparticles are used in some sunscreens.

(i) State one property of titanium dioxide nanoparticles that make them suitable for use in sunscreens.

(1)

absorb UV rays.

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Examiner Comments

The most common, correct answer. Suitable alternatives to absorb included block and reflect.

1 (a) Titanium dioxide nanoparticles are used in some sunscreens.

(i) State one property of titanium dioxide nanoparticles that make them suitable for use in sunscreens.

(1)

Radiation from the sun is reflected of off the body.

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Examiner Comments

This answer was too vague to score as there are different types of radiation emitted by the sun.

Question 1 (a)(ii)

Most candidates were able to identify a risk associated with the use of nanoparticles. The most common responses related to the fact that the long term risks are not known, or that the particles are small enough to get into the body and potentially cause some sort of harm.

Very few responses mentioned environmental impact of nanoparticles.

The responses that didn't score were either too vague or mentioned problems such as allergic reaction or skin irritation.

(ii) Suggest one possible risk associated with using nanoparticles.

(1)

There could be a long term health risk using nanoparticles as there is not enough long term regsearch into it.

ResultsPlus
Examiner Comments

A common, correct response.

(ii) Suggest one possible risk associated with using nanoparticles.

(1)

can be harmful to the body

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Examiner Comments

Unfortunately, the term harmful does not give enough detail to score.

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Examiner Tip

Be specific when using terms like harmful or hazard – say HOW harm is caused.

(ii) Suggest one possible risk associated with using nanoparticles.

(1)

some people may get an allergic reaction.

ResultsPlus
Examiner Comments

It is correct that some people may have an allergic reaction, but this is not specific to nanoparticles and does not apply to all people.

Question 1 (b)(i)

It was surprising how few candidates got this question correct, and it was obvious that candidates were not able to interpret the numbers given in the ratio. The vast majority of responses suggested that increasing diameter also increased the surface area to volume ratio whilst other responses focussed only on the relationship between diameter and surface area or volume and not on the ratio.

(i) State the trend shown by the data in Figure 1.

(1)

as the diameter of nanoparticles increases, the volume increases by 5 each time and the surface area stays the same

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Examiner Comments

It was common to see the surface area:volume ratio being unlinked and the trend being given in terms of one or the other, or in this case both.

(i) State the trend shown by the data in Figure 1.

(1)

As the diameter gets bigger the surface area to volume ratio gets smaller.

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Examiner Comments

A rare, correct answer. The candidate states the trend in simple terms

Question 1 (c)

The majority of candidates scored full marks for this question by correctly calculating the surface area and volume of the cube and then simplifying the ratio.

Some responses calculated the surface area of one face only rather than the total of all six faces which led to an incorrect ratio, while other candidates used the information given in the previous part of the question about spherical nanoparticles and simply cancelling this ratio down.

Show that the surface area : volume ratio for this cube is 1 : 10.

(3)

Total surface area = 6(60 × 60) = 6(3600) = 21600

The total volume = 60 × 60 × 60 = 60(3600) = 216000

21600 : 216000

↓ ↓

÷ 21600 ÷ 21600

↓ ↓

1 : 10

ResultsPlus
Examiner Comments

The candidate has clearly shown their calculation of surface area and volume for the cube and then simplified this down to the 1:10 ratio.

Show that the surface area : volume ratio for this cube is 1 : 10.

(3)

60nm = 3 : 30

÷3 ÷3

1 : 10

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Examiner Comments

This response used the surface area:volume ratio given for spherical nanoparticles earlier in the paper, rather than using the information given in this part of the question and scored no marks.

Question 2 (a)(i)

The most common correct answer given here was to use a gas syringe, however some candidates did correctly identify a 100cm^3 measuring cylinder as a suitable alternative. Common incorrect responses included pipette, burette and a range of gas measurers, cylinders and jars. As the second mark was dependent on the first many could not score here. Most correct responses referred to equipment being more accurate or precise, which was allowed. It was rare to see references to the preferred response of higher resolution or more gradations and many incorrect responses discussed gas not being able to escape from a syringe.

(i) Name a piece of apparatus that would be better to measure the volume of gas produced, instead of the 250 cm^3 measuring cylinder.

Give a reason for your answer.

(2)

name of apparatus

a 100cm3 measuring cylinder

reason

It would provide a more accurate result as the volume of gas produced is much smaller than a 250cm3

ResultsPlus
Examiner Comments

This response scored 2 marks – unusually mentioning a smaller measuring cylinder as an alternative to a gas syringe. Some candidates were confused and suggested a larger measuring cylinder for greater accuracy.

(i) Name a piece of apparatus that would be better to measure the volume of gas produced, instead of the 250 cm^3 measuring cylinder.

Give a reason for your answer.

(2)

name of apparatus

Gas syringe

reason

Would give a more accurate measure of the volume of ~~the~~ gas produced.

ResultsPlus
Examiner Comments

This was the most common correct answer. Most responses mentioned accuracy rather than resolution.

(i) Name a piece of apparatus that would be better to measure the volume of gas produced, instead of the 250 cm^3 measuring cylinder.

Give a reason for your answer.

(2)

name of apparatus

A burette.

reason

It has a smaller scale so the ~~gas~~ volume of gas prodweed would be easier to read and will be more accurate

ResultsPlus Examiner Comments

Burette was a common error – the volume of gas was too great to fit into a burette so this would not be a suitable alternative.

The reason given was a good explanation but could not score as this mark depended on correct apparatus being identified.

Question 2 (a)(ii)

This response required a straightforward reading from the graph and division of the two numbers (volume divided by time). A lot of candidates calculated this correctly and gave their answer to an appropriate number of significant figures. The final mark was not awarded if the calculation was not evaluated.

This is an example of a question where it was important to clearly show working and present the calculations in a way that the examiner would understand as marks could be awarded even if the final answer was not correct. Some candidates got the division upside down but could still score some marks if their working was clearly shown. Others used 1.5 minutes rather than 90 seconds but again could still score if working was shown.

Other candidates attempted the more difficult process of drawing a tangent and attempting to calculate the rate at that particular second rather than the mean rate of production of hydrogen over the period of time.

(ii) Calculate the mean rate of production of hydrogen over the first 90 seconds, in cm^3 per second.

(3)

90 seconds = 1.5 mins

$\frac{29}{1.5} = 19.3$

rate = 19.3 cm^3 per second

ResultsPlus
Examiner Comments

The candidate has made an error by converting 90 seconds into minutes. However they have clearly shown their working and scored 2 marks.

(ii) Calculate the mean rate of production of hydrogen over the first 90 seconds, in cm^3 per second.

(3)

90 seconds = 1.5 minutes

90 seconds = 29

29 / 90 = 0.32

rate = 0.32 cm^3 per second

ResultsPlus
Examiner Comments

This candidate clearly shows their working out and where the values in their calculation have come from. There are no errors and therefore this response scored 3 marks.

Question 2 (a)(iii)

Responses that simply stated that the reaction had finished did not score here because the question was looking for evidence to show that the reaction had finished. Candidates scored if their response used information from the graph to show that the reaction was complete.

The question was well answered overall with students most commonly stating that the line on the graph had plateaued or that no more gas was produced after eight minutes. Occasionally the mark was not awarded because the candidate did not explain the horizontal part of the graph properly and suggested that an optimum or maximum rate had been reached.

(iii) The student measured the volume of gas for 10 minutes.

State why the measurements could have been stopped at 9 minutes.

(1)

The graph shows that all the hydrogen was already produced at minute 9 due to the flat-line.

ResultsPlus
Examiner Comments

This reponse mentioned the flat line on the graph as well as no more gas being produced.

(iii) The student measured the volume of gas for 10 minutes.

State why the measurements could have been stopped at 9 minutes.

(1)

The reaction had ended at 8 minutes, so no more gas was being produced.

ResultsPlus
Examiner Comments

If the candidate had only stated that the reaction had ended at 8 minutes then this would have not been enough to score. However, they went on to say that no more gas was being produced and so scored the mark.

(iii) The student measured the volume of gas for 10 minutes.

State why the measurements could have been stopped at 9 minutes.

(1)

because the reaction had been completed.

ResultsPlus
Examiner Comments

This response did not give enough detail to score the mark.

Question 2 (b)(i)

There are often questions about factors that affect the rate of reaction, and this one was answered very well overall.

Most candidates scored at least one mark either by correctly stating that there would be more particles in the same volume or by stating that the frequency of collisions would increase. The best responses linked these together and achieved both marks.

There were very few blank responses – the most common incorrect responses were those that stated more collisions or more successful collisions without mentioning frequency, or that higher concentration was equivalent to a stronger acid rather than more particles.

(i) **Explain why the rate of reaction increases when the concentration of acid is increased.**

(2)

Because there are more partisles per volume, meaning they collide more frequently, which means the activation energy is higher, leading to a faster reaction

ResultsPlus
Examiner Comments

A good response that scored full marks by detailing how the increased concentration affected both the number of particles present and the likelihood of them colliding.

(i) Explain why the rate of reaction increases when the concentration of acid is increased.

(2)

the more consentrated the acid the stronger it will be making a fasster reaction.

ResultsPlus
Examiner Comments

This response did not refer to particles or collision theory at all and so did not score.

Question 3 (c)

The answer to this question was a straightforward difference between two numbers, with the final answer being given to three significant figures. Most candidates scored full marks here, although sometimes a mark was lost for giving the correct answer to either two or four significant figures.

In some cases candidates attempted complicated calculations using relative formula mass and moles to get to the final answer and making the process more difficult than it needed to be, and not always getting the correct number.

(c) When calcium carbonate is heated it decomposes.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

When 5.000 g of calcium carbonate is heated, the mass of solid remaining is 2.800 g.

Calculate the mass of carbon dioxide that has been released.

Give your answer to three significant figures.

(2)

5.000g → 2.800g + CO_2

5.000 − 2.800 = CO_2 = 2.20~~0~~g

mass of carbon dioxide = 2.20~~0~~ g

ResultsPlus
Examiner Comments

This response initially had four significant figures, but the candidate realised and corrected this to three.

(c) When calcium carbonate is heated it decomposes.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

When 5.000 g of calcium carbonate is heated, the mass of solid remaining is 2.800 g.

Calculate the mass of carbon dioxide that has been released.

Give your answer to three significant figures.

(2)

5 - 2.8 = 2.2

mass of carbon dioxide = 2.2 g

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Examiner Comments

The candidate has carried out the correct calculation but has not given the answer to three significant figures and so cannot score the second mark.

ResultsPlus
Examiner Tip

If there is a zero at the end of the number then this counts towards the number of significant figures.

(c) When calcium carbonate is heated it decomposes.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

When 5.000 g of calcium carbonate is heated, the mass of solid remaining is 2.800 g.

Calculate the mass of carbon dioxide that has been released. 5 − 2.8 = 2.2g

Give your answer to three significant figures.

(2)

CaCO3 → CaO + CO2

g | 5.000   g | 2.800   Mr of CO2 = 44

Ar/Mr | 100   Ar/Mr | 56   Mols = 0.05

Mols = 0.05   Mols = 0.05

mass of carbon dioxide = ... 2.2 .... g

Mols = mass / Mr/Ar

0.05 × 44 = 2.2

![ResultsPlus] **ResultsPlus**
Examiner Comments

This candidate did a lot of work for the single mark that they scored. The correct calculation and answer can be seen written in one line next to the question. The calculation using moles gave the same answer but the candidate did not write this to three significant figures and so did not score both marks.

Question 3 (d)(i)

Most candidates correctly identified the full outer shell of helium as the reason for it being inert and some then went on to discuss that there would be no gain or loss of electrons. Questions that use the command word 'explain' are looking for linked ideas and full marks will not be scored without this, so identifying the full outer shell alone was only enough to score one mark.

In some cases, candidates appeared not to understand what inert meant and gave answers relating to isotopes, boiling point, or density. There was also a surprising misconception that the atom is inert because it has equal numbers of protons, electrons and neutrons – demonstrating a lack of understanding about atomic structure and reactivity.

(i) Explain, using Figure 5, why helium is inert.

(2)

→ It has a full outer shell which contains 2 electrons

→ It does not need to gain any electrons or lose electrons.

ResultsPlus
Examiner Comments

Both marks given as clear bullet points.

(i) Explain, using Figure 5, why helium is inert.

(2)

The Helium has equal amounts of protons, neutrons and electrons. That is why it is inert.

ResultsPlus
Examiner Comments

Responses like this were seen quite frequently. Candidates did not always seem to know that reactivity is related to obtaining a full outer shell of electrons.

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Examiner Tip

All atoms have equal numbers of protons and electrons.

Question 3 (d)(ii)

Many candidates correctly identified the low density of helium and got this question correct. In cases where the candidate did not score the mark it was usually due to using terms like light or lightweight. Sometimes candidates compared the density of helium to oxygen which is irrelevant as the main component of air is nitrogen. Other candidates gave the answer that helium is inert even though this was already stated in the question.

(ii) Helium is used to fill balloons.

State one property of helium, apart from it being inert, that makes it suitable for filling balloons.

(1)

low density

ResultsPlus
Examiner Comments

An example of a correct response.

(ii) Helium is used to fill balloons.

State one property of helium, apart from it being inert, that makes it suitable for filling balloons.

(1)

Light weight

ResultsPlus
Examiner Comments

Although lightweight is used to mean low density in everyday life, they are not the same thing and therefore answers like this were not accepted.

Question 3 (e)

Many candidates scored one mark for correctly multiplying the number of moles by Avogadro's number and it was common for candidates to give this as their final answer, forgetting that oxygen is diatomic and contains two atoms in each molecule.

Some candidates attempted to make this calculation more difficult by including molecular mass and coming up with other answers, and sometimes candidates tried a number of different calculations and left them all for the examiner to look at. Marks cannot be awarded in this situation unless the correct method and answer is clearly selected by the candidate in the response.

(e) Oxygen gas has the formula O_2.

Calculate the number of oxygen **atoms** in 3.50 mol of oxygen gas.

(Avogadro constant = 6.02×10^{23})

(2)

$6.02 \times 10^{23} \times 3.5 \times 2 =$

number of oxygen atoms = 4.214×10^{24}

ResultsPlus
Examiner Comments

Only the most able candidates identified that the number of atoms was different to the number of molecules and scored both marks.

(e) Oxygen gas has the formula O_2.

Calculate the number of oxygen **atoms** in 3.50 mol of oxygen gas.

(Avogadro constant = 6.02×10^{23})

(2)

$3.5 \times (6.02 \times 10^{23}) = 2.107 \times 10^{24}$

number of oxygen atoms = 2.107×10^{24}.

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Examiner Comments

This response was the most commonly seen and calculated the number of oxygen molecules in 3.5 moles of oxygen.

Question 4 (a)(i)

Most answers scored two marks for correctly identifying the corrosive hazard symbol and a suitable safety precaution (the most common being gloves or goggles). Marks were sometimes lost because the symbol was incorrectly identified as harmful or irritant, and sometimes because the safety precautions given were too general such as suggesting PPE or tying hair back.

(i) The acid in Figure 6 can be used in the test for carbonate ions.

Explain, giving the name of the hazard symbol shown, what safety precautions should be taken when using this acid.

(2)

This acid is corrosive meaning it should be handled with lots of care, to stop it from spilling on anywhere or anything. Weaing gloves and goggles are the safety precautions to be taken

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Examiner Comments

A fully correct answer that identified both the symbol and a suitable safety precaution.

(i) The acid in Figure 6 can be used in the test for carbonate ions.

Explain, giving the name of the hazard symbol shown, what safety precautions should be taken when using this acid.

(2)

Gloves should be worn when handling the ~~acid~~ acid as ~~it~~ it is dangerous for ~~[illegible]~~ skin, goggles should also be worn in case it splashes in your eyes as the symbol shows it's dangerous to skin

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Examiner Comments

'Dangerous for skin', 'causes burns' and 'acid' are not suitable alternatives for corrosive and were not accepted. However, the safety precautions including gloves (and goggles) were enough to score one mark.

Question 4 (a)(ii)

The majority of responses here were correct, but nitric acid seems to be less familiar to candidates than both sulfuric and hydrochloric acid. Some incorrect responses included hydrogen nitrogen acid and hydrogen nitroxide.

Question 4 (a)(iii)

Many candidates correctly identified properties of glass, but too often these properties were not related to why it is suitable for storing corrosive chemicals and so did not score. Answers relating to transparency, strength and hardness were ignored. Some answers stated that glass was used as it is not corrosive, suggesting some confusion about the meaning of corrosive compared to corrode. The most common correct answer seen was unreactive, rather than inert or 'does not corrode'.

(iii) State a property of glass that makes it a suitable material to make the container for an acid.

(1)

It is very strong.

ResultsPlus Examiner Comments

Responses relating to physical properties of glass such as strength, transparency and durability were not relevant to this question.

(iii) State a property of glass that makes it a suitable material to make the container for an acid.

(1)

glass is inert + wont react with the acid

ResultsPlus Examiner Comments

Correct answers made references to the fact that glass is inert or unreactive.

Question 4 (b)(i)

This question was an example of candidates not giving linked ideas to form an explanation, with the majority only scoring one mark. Many recognised that the sample should be held in the flame rather than above but then did not give a reason why it needed to be in the flame (because it was hotter). The first mark was also awarded if a candidate suggested that the flame needed to be blue or roaring, but again only a few candidates could say that the blue flame should be used because it was hotter.

(b) A teacher conducts a flame test to identify the metal ions in some unknown solids.

step 1 dip a flame test wire into hydrochloric acid

step 2 dip the flame test wire into the unknown solid

step 3 hold the flame test wire above a Bunsen burner flame

(i) This method did not work well.

Explain an improvement that needs to be made to **step 3** to enable a bright flame colour to be produced.

(2)

Make sure the bunsen burner is on a blue flame because then it will be hotter and the solid will react faster (more visibly).

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Examiner Comments

This candidate scored both marks for correctly identifying an improvement and then giving a reason that this would be an improvement.

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Examiner Tip

'Explain' answers require at least two linked statements.

(b) A teacher conducts a flame test to identify the metal ions in some unknown solids.

step 1 dip a flame test wire into hydrochloric acid

step 2 dip the flame test wire into the unknown solid

step 3 hold the flame test wire above a Bunsen burner flame

(i) This method did not work well.

Explain an improvement that needs to be made to **step 3** to enable a bright flame colour to be produced.

(2)

Put the wire ~~into the~~ just into the flame, then a bright colour will be produced.

ResultsPlus
Examiner Comments

This candidate has said what the improvement would be but has not gone on to give a reason why it would be an improvement.

(b) A teacher conducts a flame test to identify the metal ions in some unknown solids.

step 1 dip a flame test wire into hydrochloric acid

step 2 dip the flame test wire into the unknown solid

step 3 hold the flame test wire above a Bunsen burner flame

(i) This method did not work well.

Explain an improvement that needs to be made to **step 3** to enable a bright flame colour to be produced.

(2)

~~[illegible]~~ dip the flame test wire in water before holding it above the bunsen burner

ResultsPlus
Examiner Comments

This candidate did not score on this question as the improvement suggested is not correct.

Question 4 (b)(ii)

This question was very well answered overall, with most candidates correctly identifying all three metal ions. The most common mistake seen was identifying a red flame as calcium rather than lithium.

Question 4 (c)

A surprising number of candidates scored no marks for this question. With all calculation questions one mark is deducted for each error made. This calculation required the conversion of volume from cm^3 to dm^3 then the multiplication of this number by two other numbers so there were numerous places where errors could occur.

Many candidates did calculate the correct answer, but there were a significant number of errors with the volume conversion leading to very large or very small answers. Some candidates forgot to multiply their calculation by twenty and calculated the mass of hydrogen chloride in one sample.

(c) A flame photometer was used to analyse samples of a solution of metal ions.

Each sample was treated with $5.00\,cm^3$ of dilute hydrochloric acid.
$1.00\,dm^3$ of the acid contained 219 g of hydrogen chloride.

Calculate the mass of hydrogen chloride in the acid used to test 20 samples.

(2)

5/1000

5/1000 x 219 = 1.095   1.095 x 20 = ~~21.9~~ 21.9

mass = 21.9 g

ResultsPlus
Examiner Comments

This response shows a fully correct answer. The candidate has set out their work clearly and showed all working out.

(c) A flame photometer was used to analyse samples of a solution of metal ions.

Each sample was treated with $5.00\,cm^3$ of dilute hydrochloric acid.
$1.00\,dm^3$ of the acid contained 219 g of hydrogen chloride.

Calculate the mass of hydrogen chloride in the acid used to test 20 samples.

(2)

~~1 dm³ = 219 g~~ 1 dm³ ÷ 1000 = 1 cm³ ~~1 cm³ ÷ 1000 = 1 dm³~~

~~1 dm³ × 1000 = 219 × 1000~~ 219 g ÷ 1000 = 0.219 g ~~1 cm³ = 1 dm³ × 1000~~

~~1 cm³ = 219000~~ 0.219 g × 5 = 1.095

~~1 cm³ × 5 = 219000 × 5~~

mass = 1.095 g

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Examiner Comments

This candidate scored 1 mark. They have correctly calculated the mass of hydrogen chloride in one sample but have not gone on to multiply this answer by 20.

(c) A flame photometer was used to analyse samples of a solution of metal ions.

Each sample was treated with 5.00 cm^3 of dilute hydrochloric acid.
1.00 dm^3 of the acid contained 219 g of hydrogen chloride.

Calculate the mass of hydrogen chloride in the acid used to test 20 samples.

(2)

1 dm³ = 1/10000 cm³
219 x 5 = 1095
1095 x 10,000 = 10950000 g
10950000 x 20 = 219000000

mass = 219,000,000 g

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Examiner Comments

It was common to see errors in converting the volume from cm^3 to dm^3.

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Examiner Tip

Practice converting quantities into bigger and smaller units.

Question 5 (a)(i)

This question was well answered, and most candidates scored full marks for identifying that the diesel engine produced more nitrogen oxides and particulates. Where marks were lost it was usually due to the response discussing unburnt hydrocarbons or misreading of the values in the table.

Some responses quoted the numbers from the table directly without any comparison and therefore did not score any marks.

Many candidates gave far more information than was required in order to answer this question and offered explanation rather than the statements that the question asked for.

(i) Give **two** ways in which the data in Figure 8 shows that the diesel engine is **more** damaging to the environment than the petrol engine.

(2)

releases more unburnt hydrocarbons and way more nitragon oxides

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It was common to see responses suggesting that diesel engines release more unburnt hydrocarbons, even though this is not correct.

(i) Give **two** ways in which the data in Figure 8 shows that the diesel engine is **more** damaging to the environment than the petrol engine.

(2)

The diesel engine gives out more nitrogen oxides and particulates in g per km driven which is higher than the petrol engine.

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Examiner Comments

This candidate clearly shows a comparison of the two engines in their answer, and scores both marks.

Question 5 (a)(ii)

Another well answered question with many responses scoring full marks, usually relating the carbon dioxide emissions to increasing greenhouse effect or global warming. It was less common to see responses linking sulfur dioxide emissions to acid rain.

Responses that did not score usually (correctly) discussed the toxic effects of carbon monoxide, however this did not answer the question.

(ii) Explain, using information from Figure 8, **one** way in which the diesel engine is **less** damaging to the environment than the petrol engine.

(2)

The diesel engine produces less carbon monoxide, which is better as carbon monoxide is a toxic gas, which replaces oxygen in haemoglobin in the blood.

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Examiner Comments

The candidate has given correct information about carbon monoxide, however it is not an environmental issue but a health issue.

(ii) Explain, using information from Figure 8, **one** way in which the diesel engine is **less** damaging to the environment than the petrol engine.

(2)

The diesel engine produces less sulfur dioxide which causes acid rain, which ~~damag~~ damages aquatic ecosystems.

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Examiner Comments

It was less common to see answers referring to sulfur dioxide emissions and their impact on the environment. This answer gives two linked points ('less sulfur dioxide'... 'causes acid rain') and scored both marks.

(ii) Explain, using information from Figure 8, **one** way in which the diesel engine is **less** damaging to the environment than the petrol engine.

(2)

Diesel produces less carbon dioxide than petrol when complete combustion occurs. CO_2 is a greenhouse gas & contributes to global warming.

ResultsPlus
Examiner Comments

It was more common to see answers referring to the lower quantities of carbon dioxide released from the diesel engine. This candidate has then gone on to correctly link this to the fact that carbon dioxide is a greenhouse gas.

Question 5 (b)(iii)

Writing balanced equations remains a challenge for a significant number of candidates, although most managed to score some marks for this question. Knowledge of the reactants and products of complete combustion were required, as well as the formulae of these. Many candidates were able to provide either the formulae of the reactants or the products and score a mark. In cases where candidates got all formulae correct, they usually went on to balance the equation correctly.

Common mistakes here included the incorrect formula for oxygen and incorrect balancing of the correct formulae. Candidates often rounded 12.5 to 12 or 13 for oxygen rather than leaving it or doubling up all the balancing numbers to get whole numbers.

(iii) Write the balanced equation for the complete combustion of octane, C_8H_{18}.

(3)

~~$C_8H_{18} + O_2 \rightarrow CO_2 + H_2O$~~

$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

ResultsPlus
Examiner Comments

This response scored full marks. The candidate has clearly written the correct formulae for all products and reactants and then gone on to correctly balance the equation using whole numbers.

(iii) Write the balanced equation for the complete combustion of octane, C_8H_{18}.

(3)

$C_8H_{18} + 12.5O_2 \longrightarrow 8CO_2 + 9H_2O$

ResultsPlus
Examiner Comments

This response scored full marks using 12.5 in front of the oxygen to correctly balance the equation without doubling everything.

(iii) Write the balanced equation for the complete combustion of octane, C_8H_{18}.

(3)

$C_8H_{18} + O_2 \longrightarrow$ ~~[illegible]~~ $C_8O_2 + H_{18}$

ResultsPlus
Examiner Comments

This response scored 1 mark. The candidate had given the correct formula for the reactants, but had not correctly identified the products and so could not score the remaining marks.

Question 6 (a)

Many candidates correctly identified bromine, with the most common error being to forget about Period 1 and giving iodine as the answer. A number of candidates gave an answer of carbon.

Question 6 (b)

Questions about the reactivity of the halogens are usually challenging for candidates, and this was no exception. For some reason candidates seem to find answering this question more difficult than the equivalent question about alkali metals. It is common to see the same reasoning for the reactivity of alkali metals incorrectly applied to the halogens.

There was a wide spread of marking points, with the best answers giving a clear and concise explanation. However, most candidates managed to score a mark for identifying that chlorine is smaller than iodine and many of these then also went on to say that chlorine would gain an electron more easily. It was less common to see responses that discussed the force of attraction between the nucleus and outer electrons. Some candidates lost a mark for stating that iodine had more outer shells than chlorine.

(b) Explain why chlorine is more reactive than iodine.

(3)

Because chlorine is higher up in the halogen so is more reactive because in the halogens the reactivity goes from least to most ↑ Most ↓ Least and chlorine is higher up.

ResultsPlus
Examiner Comments

See below

ResultsPlus
Examiner Tip

This candidate did not score here as there is no explanation in this response, just a statement that the halogens are more reactive towards the top of the group.

(b) Explain why chlorine is more reactive than iodine.

(3)

• chlorine is higher than iodine in the table

• chlorine has less electron shells, meaning the nucleus is closer to the ~~furthest~~ outer shell ~~than it is with iodine~~. compared to iodine, ~~which~~ which has its nucleus further away from the outer shell.

ResultsPlus
Examiner Comments

This response scored one mark. The candidate has repeated the same point three times, about the distance between the nucleus and the outer electron shell. There is no mention of the force of attraction between the outer electrons and the nucleus or how easily an electron is gained.

ResultsPlus
Examiner Tip

Every atom contains only one outer shell. Candidates lost marks for stating that iodine has more outer shells than chlorine.

(b) Explain why chlorine is more reactive than iodine.

(3)

Chlorine has less electron shells than iodine meaning that the outer (e⁻) shell is closer to the nucleus. This makes it easier for the outer shell to gain an electron because there is a stronger attraction closer to the nucleus than further from it. This makes chlorine more reactive than iodine.

ResultsPlus
Examiner Comments

A good explanation including all three marking points that scored full marks.

Question 6 (c)

This question was very well answered overall with many candidates giving either the name or the correct formula of sodium chloride. Only a few responses gave the generic answer of 'salt' or 'table salt'.

Question 6 (d)(i)

This question tended to score either full marks or no marks at all. Candidates needed to get all formulae correct to score the first mark, and if they did this successfully then they were usually able to balance the equation and score the second mark as well.

Common errors were to give the formula of sodium bromide as Na_2Br or $NaBr_2$ and some did not remember that bromine is diatomic. Some candidates included water or hydrogen as a product and a few used S as the symbol for sodium.

(d) Sodium also reacts with bromine. Na^+ Br^-

(i) Write the balanced equation for the reaction between sodium and bromine. **(2)**

$2Na + Br_2 \rightarrow 2NaBr$

ResultsPlus
Examiner Comments

This candidate got all of the formulae correct and has then gone on to balance the equation correctly as well.

ResultsPlus
Examiner Tip

The halogens form diatomic molecules when they have not reacted with other elements.

(d) Sodium also reacts with bromine.

(i) Write the balanced equation for the reaction between sodium and bromine. **(2)**

$Na + Br_2 \rightarrow NaBr$

ResultsPlus
Examiner Comments

It was very unusual to see this question scoring only one mark. Here the candidate has given the correct formulae throughout but has not attempted to balance the equation.

Question 6 (d)(ii)

This was not well answered and there were a wide range of answers including fizzing and white precipitate. Some candidates were aware that bromine would be displaced in the reaction but gave the colour as combinations of red and brown – the colour associated with bromine rather than the orange of bromine solution. Combinations of red and brown were not accepted as these are the colours associated with iodine solution. It appears that many candidates are not familiar with the observations of halogen displacement reactions and have not actually seen these reactions before. It is important that candidates are aware that halogen solutions are not the same colour as the pure halogens.

(ii) In another experiment, a student adds colourless sodium bromide solution to chlorine water.

State what you would **see** in this reaction.

(1)

an orange solution form

ResultsPlus
Examiner Comments

The candidate correctly identified the colour of bromine solution. The solution can sometimes look yellow if it is very dilute so answers stating shades of orange and yellow were accepted.

(ii) In another experiment, a student adds colourless sodium bromide solution to chlorine water.

State what you would **see** in this reaction.

(1)

the liquid will become ~~of~~ dark brown.

ResultsPlus
Examiner Comments

Iodine solution is brown, therefore colours that were only shades of brown were not accepted. Neither was red-brown, which is the colour of pure bromine.

ResultsPlus
Examiner Tip

Halogen solutions are different colours compared to the pure halogen that they are made from.

(ii) In another experiment, a student adds colourless sodium bromide solution to chlorine water.

State what you would **see** in this reaction.

(1)

A colour change ~~as~~ to

ResultsPlus
Examiner Comments

This response was too vague to score. The actual colour needed to be given in the answer.

(ii) In another experiment, a student adds colourless sodium bromide solution to chlorine water.

State what you would **see** in this reaction.

(1)

white precipitate

ResultsPlus
Examiner Comments

A number of incorrect responses stated that a precipitate would form, with white being the most common colour.

Question 6 (d)(iii)

Responses to this question showed that overall candidates had a good understanding of what oxidation is and which species would be oxidised. Unfortunately, most only scored one mark because they incorrectly identified the bromide ion as bromine, either being completely incorrect or not realising that bromine and bromide are different species and using the terms interchangeably. Answers referring to chlorine or chloride were less common but were seen. It was more likely that a response would score zero for incorrectly stating bromine (meaning bromide) but then not giving enough of an explanation to achieve the second marking point.

(iii) The ionic equation for the reaction between sodium bromide and chlorine is:

$$2Br^- + Cl_2 \rightarrow 2Cl^- + Br_2$$

Explain which species has been oxidised in this reaction.

(2)

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

bromide ions have been oxidised (lost 2 electrons) to form bromine.

ResultsPlus
Examiner Comments

This candidate scored full marks with a correct half equation and then went on to confirm the mark with a correct description as well.

ResultsPlus
Examiner Tip

Marks can be awarded from correct equations.

(iii) The ionic equation for the reaction between sodium bromide and chlorine is:

$$2Br^{-} + Cl_2 \rightarrow 2Cl^{-} + Br_2$$

Explain which species has been oxidised in this reaction.

(2)

The bromine as it's lost electrons since it went from Br^{-} to Br which means it lost electrons to gain a full outer shell

ResultsPlus
Examiner Comments

Answers similar to this were the most commonly seen, scoring one mark. The candidate has given the formula of a bromide ion but also states that bromine has lost electrons, which is incorrect and negates the correct formula given.

Question 7 (a)

Most candidates scored both marks on this question for identifying plants and photosynthesis, although there has been an increase in the number of candidates talking about photosynthesising bacteria, which was also credited. When marks were lost it was usually due to not giving enough of a description of photosynthesis to be awarded the second mark.

Some candidates did not answer the question that was asked and instead gave answers that discussed various methods of removing carbon dioxide from the atmosphere or how human activities increase carbon dioxide in the atmosphere and while these were usually correct, they could not score any marks.

(a) The percentage of oxygen in today's atmosphere is greater than the percentage of oxygen in the Earth's early atmosphere.

Explain what caused this change to happen.

(2)

The earth's early atmosphere contained ~~lot~~ lots of CO_2. When green plants evolved, they used this CO_2 in photosynthesis to produce oxygen. The percentage of CO_2 decreased while the percentage of oxygen increased.

ResultsPlus
Examiner Comments

A good explanation, linking the evolution of plants with photosynthesis and therefore the production of oxygen.

(a) The percentage of oxygen in today's atmosphere is greater than the percentage of oxygen in the Earth's early atmosphere.

Explain what caused this change to happen.

(2)

Oxygen was formed more when there was a lot of water vapour, there are also more plants on Earth than there was, these plants release oxygen.

ResultsPlus
Examiner Comments

This response scored one mark for correctly identifying plants and goes on to state that plants release oxygen. However, this is not linked to photosynthesis (or a correct description of photosynthesis) so did not score the second mark.

(a) The percentage of oxygen in today's atmosphere is greater than the percentage of oxygen in the Earth's early atmosphere.

Explain what caused this change to happen.

(2)

Earths early atmosphere was full with pollutants as the Earth was still a glowing rock with a lot of volcanoes.

ResultsPlus
Examiner Comments

This response makes no links to oxygen or plants at all and does not answer the question that is being asked.

Question 7 (b)

This question was poorly answered, with many responses scoring no marks. Answers often referred to looking at the contents and deciding whether there was any metal left or testing for remaining oxygen using a glowing splint. It seems likely that only some of the candidates had ever seen or done this experiment, and although this type of question has been asked before only a few candidates scored both marks.

The student could test for oxygen by taking some of the gas in a test tube, ~~and then~~ placing a glowing splint in the test tube and watching for it to relight. If it does oxygen is still present.

ResultsPlus
Examiner Comments

It was quite common to see suggestions of testing to see if there was any unreacted oxygen remaining. Candidates did not seem to realise that oxygen would be freely available in the atmosphere and that the test for oxygen only works in high oxygen concentrations.

Student could check if there is no more magnesium ribbon in the crucible and it has turned into a white powder.

ResultsPlus
Examiner Comments

This candidate suggested looking for unreacted magnesium in the crucible, which is not a reliable method of checking whether the reaction is complete.

The student could continue to heat the crucible after weighing the products to check if there is a further change in mass by weighing again. If not, then magnesuim had reacted completely with oxygen.

ResultsPlus
Examiner Comments

A good description that scored both marks.

Question 7 (c)

This question was attempted by most candidates and most responses scored either two or four marks. Calculation of empirical formula is a common question and candidates seemed to be confident in calculating this, which allowed the first two marks to be awarded. Errors here included using an atomic mass of 32 for oxygen or reversing the division and ending with an answer of P_4O_5. When candidates correctly calculated P_2O_5 some then didn't know how to proceed further and stopped here. However, a lot of responses then went on to get to the correct answer, via a number of different methods including the calculation as expected or recognising the ratio in the initial masses given. Some gave a final answer of $2P_2O_5$, recognising the factor of two but not quite getting the final answer correct.

(c) In another experiment, it was found that 1.24 g of phosphorus reacted completely with 1.60 g of oxygen to form phosphorus oxide.

The relative formula mass of this phosphorus oxide is 284.

Deduce the molecular formula of this phosphorus oxide.

You must show your working.

(relative atomic masses: O = 16, P = 31)

(4)

P O

1.24/31 1.6/16

0.04 0.1

1 2.5

2 5

P_2O_5

molecular formula = P_2O_5

ResultsPlus Examiner Comments

This was a common two mark response. The candidate correctly calculated the empirical formula of the compound but did not go on to calculate the molecular formula.

(c) In another experiment, it was found that 1.24 g of phosphorus reacted completely with 1.60 g of oxygen to form phosphorus oxide.

The relative formula mass of this phosphorus oxide is 284.

Deduce the molecular formula of this phosphorus oxide.

You must show your working.

(relative atomic masses: O = 16, P = 31)

(4)

1.60g / 16 = 0.1 mol 1.24g / 31 = 0.04 mol

0.1 / 0.04 = 2.5 2.5 : 1 O : P 5 : 2 P : O 2 : 5

Empirical formula = P_2O_5

RFM of Empirical formula = (31×2) + (16×5) = 142

284 / 142 = 2

Molecular formula = $P_{(2\times2)}O_{(5\times2)}$ = P_4O_{10}

molecular formula = P_4O_{10}

ResultsPlus
Examiner Comments

The answer of P_4O_{10} without any working or calculation shown would not have scored any marks. This candidate scored full marks, clearly setting their work out and making it easy for the examiner to understand.

Question 7 (d)(i)

There were surprisingly few two mark responses to this question, considering that there were two correct answers. Again, it appears that a significant number of candidates are unfamiliar with this experiment. There were a lot of one mark responses that identified that the iron would rust or turn orange / brown but not all candidates managed to clearly explain why this change would happen. Equally there were a number of responses that identified that the water level in the test tube would rise but very few correct explanations as to why this would happen.

Some candidates clearly had no idea what to expect as there were responses referring to the iron wool falling into the water or drying out, while others mentioned that some of the water in the beaker would evaporate or that water level would decrease in the test tube.

(i) Explain one change the student would see after a few days.

(2)

the water will have moved up the test tube.

ResultsPlus
Examiner Comments

This candidate scored one mark for stating a correct observation but not going on to explain it.

(i) Explain one change the student would see after a few days.

(2)

The water level in the test tube would rise because the oxygen would react with iron leaving less gas in the test tube

ResultsPlus
Examiner Comments

This candidate scored both marks for recognising that the water level in the test tube would rise and for linking this to the oxygen from the air reacting with the iron wool in the tube and there being less gas in the tube after the reaction.

(i) Explain one change the student would see after a few days.

(2)

The iron will react with oxygen to form iron oxide (rust)

ResultsPlus
Examiner Comments

This candidate almost didn't score both marks. They correctly stated that the iron would react with oxygen but the formation of iron oxide is not an observation – the colour or statement of rust is an observation and is what scored the other mark.

Question 7 (d)(ii)

This response was also low scoring with a significant number of blank responses, which reinforced the idea that this was an unfamiliar practical to many candidates. There were suggestions of counting bubbles, measuring change in mass, putting a lid onto the water, and even removing oxygen from the air and water.

When candidates identified that a way to measure the change in gas volume would be an improvement, replacing the test tube with a gas syringe was a common incorrect answer. However, some students did identify that replacing the test tube with a measuring cylinder or something with measurements would be an improvement. Only the most able candidates were able to explain that this would measure the volume of oxygen used in the reaction.

(ii) Explain one change that can be made to the apparatus in Figure 10 to allow the student to calculate the percentage of oxygen in the atmosphere.

(2)

Using a measuring cylinder ^instead of a test tube allows the student to read the amount of oxygen taken up and find it as a percentage of the initial volume of the air.

ResultsPlus
Examiner Comments

This candidate has shown a good understanding of the question. They have recognised that the oxygen in the test tube will react and leave the air, and that the change in volume of the gas represents the volume of oxygen used. They have stated a suitable alternative to the test tube (a measuring cylinder) and explained how it can be used to measure this volume change.

(ii) Explain one change that can be made to the apparatus in Figure 10 to allow the student to calculate the percentage of oxygen in the atmosphere.

(2)

Instead of using a test tube you should use a gas syringe in order to directly read and measure the amount of gas produced.

ResultsPlus
Examiner Comments

This candidate has misunderstood the question and given a way of measuring the volume of a gas produced in a reaction. This reaction uses oxygen and so a gas syringe is not a suitable way of measuring the gas that is being used in a reaction.

Question 8 (a)(ii)

It was very obvious when candidates had had experience of this practical as they could clearly explain how to carry out the tests and what the results would be and there were a good number of four mark responses. When candidates were familiar with the test but did not score full marks it was usually due to the addition of an acid before the sodium hydroxide or not stating that the calcium hydroxide precipitate would remain when excess sodium hydroxide was added. Some candidates lost a mark for stating that the aluminium precipitate would turn colourless rather than saying it redissolves.

Some candidates suggested the use of a flame test to identify calcium ions, which was accepted but as aluminium would not give a flame colour in a standard flame test then this could not score full marks.

(ii) You are given two solutions, one containing Ca^{2+} ions and the other containing Al^{3+} ions.

Devise a plan to identify which solution is which.

(4)

- use same volume of sodium hydroxide and pour into both solutions ~~th~~
- If their are Ca^{2+} ions present then the solution will turn ~~[illegible]~~ white
- Aluminium will also turn white.
- However you can add the sodium Hydroxide in excess which will turn the Al^{3+} solution colourless while the Ca^{2+} solution will remain white.

ResultsPlus
Examiner Comments

This response scored full marks. The candidate has clearly stated how to carry out the test using sodium hydroxide and the expected results in both cases. This means that both solutions can be confirmed as definitely containing calcium ions and definitely containing aluminium ions.

(ii) You are given two solutions, one containing Ca^{2+} ions and the other containing Al^{3+} ions.

Devise a plan to identify which solution is which.

(4)

Aluminium and Calcium both produce white precipitates. Therefore using excess sodium hydroxide will cause the Aluminium ~~to t~~ precipitate to turn colourless and the Calcium precipitate will not change. Therefore after excess sodium hydroxide is added to the solution containing the metal ions and the precipitate turns clear, aluminium ions are present if not, calcium ions are present.

ResultsPlus
Examiner Comments

The response states that both solutions will produce a white precipitate and then goes on to mention the addition of sodium hydroxide so was given the benefit of the doubt. However, it then goes on to state that the precipitate turns clear, which is not the same as the precipitate dissolving so this response only scored three marks.

(ii) You are given two solutions, one containing Ca^{2+} ions and the other containing Al^{3+} ions.

Devise a plan to identify which solution is which.

(4)

You could do a flame test. Dip ~~a~~ a flame test wire into hydrochloric acid. Then dip the flame test wire into one of the unknown solid. Hold the flame test wire ~~on~~ ~~on~~ over the blue part of the flame. If the flame turns a orange-red colour then ~~it is~~ the solid is calcium and the other one is aluminium. If it does not go orange-red then it is aluminium. ~~You could~~

ResultsPlus
Examiner Comments

This response gave a good description of the flame test for calcium ions, rather than giving a test that would prove that both calcium ions and aluminium ions were present in the solution. Responses that did not give positive identification of both ions scored a maximum of two marks.

Question 8 (b)

The first of the six mark questions required candidates to identify three different compounds based on properties and various tests, with explanations to support their identification. Most candidates attempted this question and there was a wide range of scores.

The most able candidates were able to deduce the identity of all three compounds using the data in the table, whereas the least able candidates simply reworded the information in the table and scored no marks. Most candidates correctly identified some of the compounds and gave correct information about them based on properties and results.

Many candidates correctly identified W as ammonia, although some called it ammonium gas. Where this was not identified incorrectly, candidates tended to think that the gas was chlorine, and had mixed up their litmus tests.

Fewer candidates correctly identified X as silver bromide or containing bromide ions although they could usually recognise the test for halide ions. It was quite common for candidates to go on to identify X as bromine, in spite of the appearance being a cream precipitate.

A number of candidates correctly identified W and X but then did not link this together to deduce that V was ammonium bromide, although they could deduce that V was ionic based on its properties. It was common to suggest that the white crystals were sodium chloride or calcium or aluminium – presumably carrying forward from the previous part of the question.

Use the data in Figure 11 to deduce information about **V**, **W** and **X**, explaining your deductions.

(6)

Where sodium hydroxide solution is added to solid V and is warm ~~to~~ it shows that the pungent gas is chlorine as chlorine turns damp litmus paper blue.

V has a high melting point, conducts electricity as a solution of V but as a solid it doesn't conduct electricity. V is also a white solid

the last column involving nitric acid and silver nitrate must react with a solution of sodium thiosulfate and hydrochloric acid to perform the test for rate of reaction. if the black mark on the bottom of the flask goes it shows how temperature affects rate of reaction so the ~~cream~~ cream precipitate must be a solution of sodium thiosulfate and hydrochloric acid.

ResultsPlus
Examiner Comments

This response initially looks as though it should score marks, but it is not worth anything. The candidate has incorrectly identified gas W and mixed up litmus tests for chlorine and ammonia, and has also gone on to confuse testing for halide ions with the disappearing cross reaction practical. The middle paragraph about substance V simply repeats information that is given in the table.

ResultsPlus
Examiner Tip

Marks are not awarded for repeating information given in the stem of the question.

Use the data in Figure 11 to deduce information about **V**, **W** and **X**, explaining your deductions.

(6)

- When dilute nitric acid is added to V and silver nitrate solution is added, a ~~white~~ cream precipitate forms, this suggests that the solution of V contains chlorine.
- The appearence of V tells us that the substance is a solid at room temperature
- Solid V does not conduct electricity, but a solution of V does. this shows that it is covalently bonded, since as a solution, the electrons are free to move around and conduct, whilst as a solid, the electrons cannot move ~~ax~~; they vibrate in fixed positions.
- When NaOH is added to ~~solution~~ solid V and gently warmed, X is produced
- X is likely to be ammonia gas, due to its distinct

pungent smell, and the test that turns damp litmus paper blue, W is ammonia gas

- This means that solid V may have ammonium.
- When heated to 400 °C, solid V does not melt, this means that solid V is a large covalent structure since lots of energy is needed to overcome the covalent bonds

ResultsPlus
Examiner Comments

This is an example of a level 1 response. The candidate has incorrectly identified V as containing covalent bonds and chlorine. They then go on to initially state that X is ammonia, but then change this to W and then correctly deduce that V contains ammonium ions, which is enough for level 1.

Use the data in Figure 11 to deduce information about **V**, **W** and **X**, explaining your deductions.

(6)

X is bromine. ~~this~~ This is because the test used to find it was the halide test and a white precipitate is chlorine, a yellow one is iodine and cream one is bromine, therefore ion X is bromine.
W is ammonia, this is as ammonia turns damp litmus paper blue and is produced when NaOH is added to ammonium, so the ion was ammonium and W is ammonia.
V must be ionic bonding as it conducts only as a liquid when its ions are able to move and has a very high melting point. As the cation is ammonium and the anion is chloride, V must be ~~ammonium~~ ammonium chloride, or ~~NH_4Cl~~ NH_4Cl.

ResultsPlus
Examiner Comments

An example of a level 2 response. The candidate correctly identifies the halide ion test and the correct result but states bromine instead of bromide. They correctly identify W as ammonia and give a reason, and deduce from this that V contains ammonium ions. They then go on to correctly deduce that V must be an ionic compound but name it incorrectly as ammonium chloride, which seems to be a simple mistake as bromide (bromine) had been discussed at the beginning of the answer. This would have been a level 3 response if V had been correctly identified.

This is an example of a Level 3 response scoring six marks.

Use the data in Figure 11 to deduce information about V, W and X, explaining your deductions.

(6)

(bromide) NH_4Br

The solid V must be ammonium because it's white and an ionic compound so it doesn't conduct electricity as a solid as ions can't move and carry a charge but in solution it conducts electricity because the ions can move and carry on a charge. The solid doesn't melt at 400°C, because it has a high melting point (due to strong electrostatic forces of attraction which require lots of energy to separate) like ammonium bromide, NH_4Br.

When sodium hydroxide is added to the solid V and warmed, W is released which must be ammonia gas as it's pungent and turns damp red litmus paper blue as it's akaline. $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$

The cream precipitate X must be AgBr, silver bromide, as the cream colour indicates bromide ions, if solution V contains ammonium ions and bromide ions, it must be ammonium bromide.

$Ag^+ + Br^- \rightarrow AgBr$

The test for bromide ions is dilute nitric acid & silver nitrate solution to form cream precipitate.

V must be ammonium bromide. The presence of ammonium ions (NH_4^+) is confirmed by the damp red litmus paper turning blue, and bromide ions (Br^-) is confirmed by cream precipitate.

W must be ammonia gas (NH_3) as it turns damp litmus paper blue.

X must be silver bromide, AgBr as the cream colour indicates bromide ions (Br^-).

ResultsPlus
Examiner Comments

The candidate has correctly identified all three compounds and even included reaction equations and formulae, showing good understanding of ion tests and their results. They have given a detailed explanation of their deductions and summarised the information well on the second page.

ResultsPlus
Examiner Tip

There is actually enough information just on the second page to award a level 3 response because it contains the identification of all compounds with a correct justification for each.

Question 9 (a)(ii)

This question was very well answered with many candidates scoring either three or four marks. Candidates have obviously had practice at energy change calculations and are familiar with carrying them out.

Common mistakes in this question included reversing the calculation, forgetting to add the minus sign to the final answer, doubling up the reactant energies or not doubling up the product energy. However, all errors were carried forward and most responses managed to score some marks.

Calculate the energy change for this reaction.

(4)

$H_2 + F_2 \longrightarrow 2HF$

(438 x 2) + (158 x 2) - (562 x 2)

872 + 316 - 1124

1188 - 1124

= 64 so it is endothermic

energy change = 64 kJ mol^{-1}

ResultsPlus Examiner Comments

The candidate incorrectly doubled the bond energy values for the reactants, but correctly calculated the bond energy for the product.

They then correctly calculated reactant energy minus product energy and gave their answer with the correct sign for their calculation and therefore scored three marks out of four as there was only one mistake throughout the calculation.

Calculate the energy change for this reaction.

(4)

562 x 2 = 1124

1124 - (158+436) = 530

energy change = 530 kJ mol^{-1}

ResultsPlus
Examiner Comments

The candidate has correctly calculated the bond energy values for both the products and the reactants. Unfortunately they have then carried out the calculation back to front and ended up with a positive value for the energy change. The value is correct but there should be a minus sign indicating an exothermic reaction and so scored three marks.

Calculate the energy change for this reaction.

(4)

H-H + F-F → ~~2(H-F)~~ 2(H-F)

436 + 158 → (2 × 562)

~~~~ 594 → 1124

594 − 1124 = −530

energy change = −530 kJ mol^{-1}

ResultsPlus
Examiner Comments

A fully correct answer, with calculations and working out clearly shown.
~~~~

Question 9 (b)

The second six mark question was better answered than the first overall, and most responses received some credit with many responses being awarded four or more marks.

The iron catalyst used in the Haber Process was the most commonly seen example although there were a lot of examples of enzymes being used in digestion or in fermentation and a few examples of catalytic converters or catalytic cracking.

While it was clear that many candidates knew how a catalyst worked, it wasn't always well explained and linked together. Most candidates were able to define a catalyst as something that increases the rate of reaction without being used up in the reaction, but again this wasn't always well explained or communicated. Lower scoring responses could identify that catalysts reduce activation energy but couldn't link this to the increased rate of reaction. The most able candidates gave a good explanation of this. Common misconceptions about catalysts are that they increase the amount of energy that the particles have and that catalysts increase activation energy. Some candidates also thought that increasing surface area or concentration of reactants was a catalyst, and that adding heat to a reaction was a catalyst.

*(b) The reaction profile for an uncatalysed exothermic reaction is shown in Figure 13.

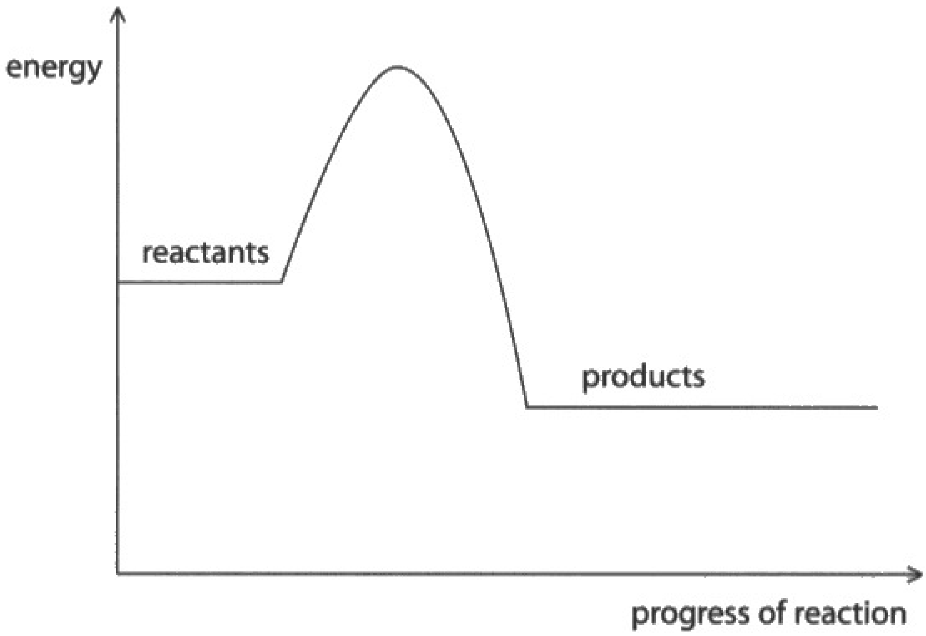


Figure 13

Using some examples of catalysts you have met in chemistry, discuss what catalysts do and their effect on the activation energy of a reaction.

You can use Figure 13 to illustrate your answer.

(6)

Catalysts help to speed up a reaction without getting used up, by lowering the activation energy.

Activation energy in the minimum amount of energy required to start a reaction.

Catalysts increase the number / frequency of collisions, which increases the rate of reaction.

An example would be an iron catalyst which is used in the production of ammonia.

A catalyst provides an alternative reaction pathway that is ~~much~~ quicker and much more efficient.

ResultsPlus
Examiner Comments

A level 3 response. The candidate has clearly explained the role and function of a catalyst by explaining what a catalyst does (speeds up a reaction without being used up) along with how it does this (by providing an alternative reaction pathway with a lower activation energy). They then go on to give a correct example of a catalyst and the process it is used in. Although there is no annotation on the graph there is enough information in the answer to put this into level 3.

*(b) The reaction profile for an uncatalysed exothermic reaction is shown in Figure 13.

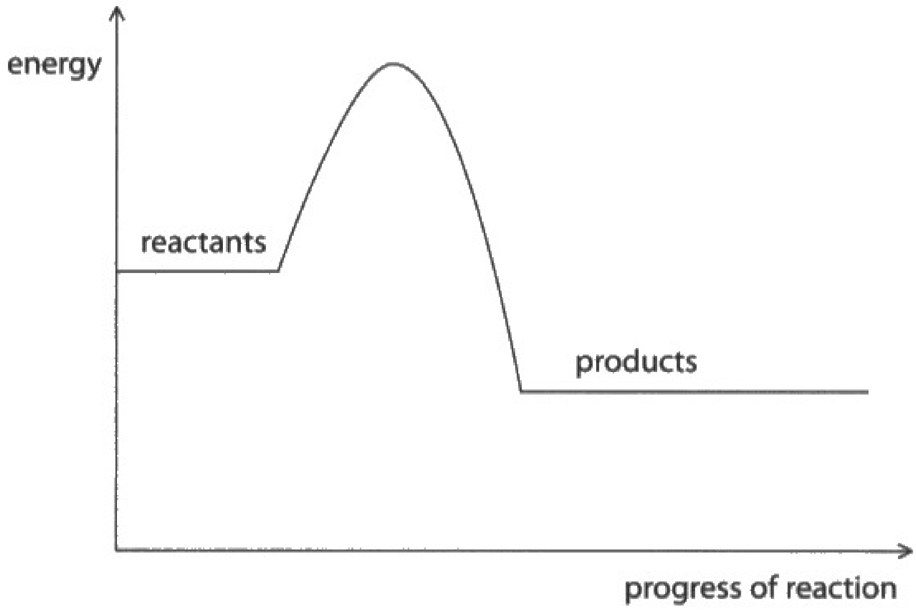


Figure 13

Using some examples of catalysts you have met in chemistry, discuss what catalysts do and their effect on the activation energy of a reaction.

You can use Figure 13 to illustrate your answer.

(6)

Catalysts speed up the rate of a reaction without being used up. The mass of a catalyst remains unchanged throughout the reaction and is ~~the~~ the same before and after the reaction. Catalysts speed up the rate of reaction by giving the ~~reaction~~ reaction an alternate pathway which ~~the~~ lowers the activation energy required for the reaction to take place. This means that more ~~[illegible]~~ frequent successful collisions take place as more particles have the activation energy needed ~~[illegible]~~ to start a reaction. Activation energy is the minimum ~~a~~ energy required for the reaction to take place. A lower activation energy means more frequent successful ~~eoa~~ collisions therefore increases the rate of reaction.

ResultsPlus
Examiner Comments

This is a good and detailed explanation of the role and function of a catalyst, easily scoring at the top of level 2. Unfortunately the candidate could not achieve level 3 because there are no examples of any catalysts in the response, which is asked for in the question.

ResultsPlus
Examiner Tip

Read the question carefully and make sure that all points in the question are responded to.

*(b) The reaction profile for an uncatalysed exothermic reaction is shown in Figure 13.

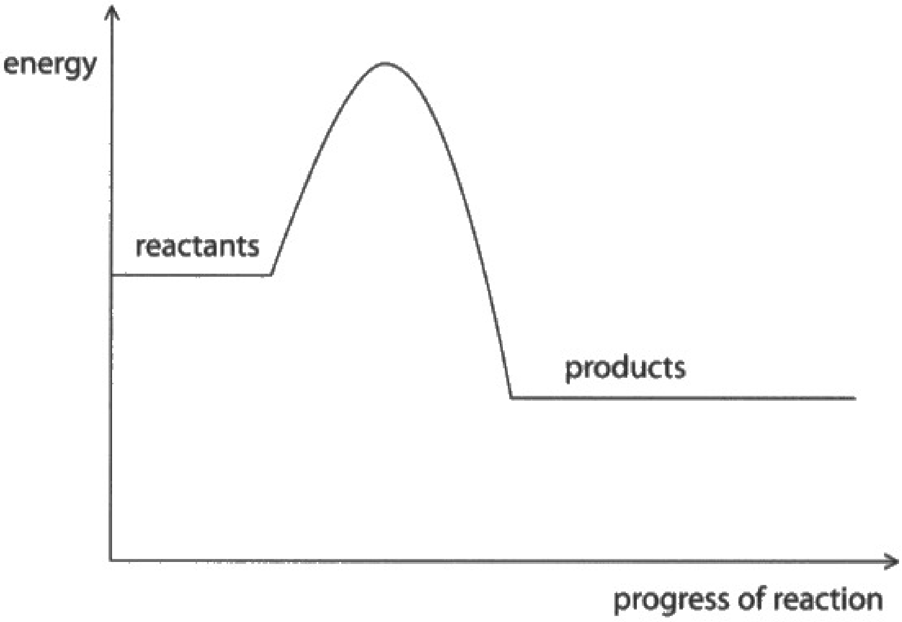


Figure 13

Using some examples of catalysts you have met in chemistry, discuss what catalysts do and their effect on the activation energy of a reaction.

You can use Figure 13 to illustrate your answer.

(6)

catalysts are used to speed up reactions. This is done by providing an alternate reaction pathway for the reactants.

Catalysts speed up the ~~prog~~ ~~reactants with~~o reaction without reacting with the reactants.

Catalysts lower the amount of activation energy required for the reaction to start. This also lowers the overall energy change.

ResultsPlus Examiner Comments

This shows a 3 mark answer.

There is no mark done on the diagram and no examples of catalysts. However, the candidate gives some correct statements about catalysts.

*(b) The reaction profile for an uncatalysed exothermic reaction is shown in Figure 13.

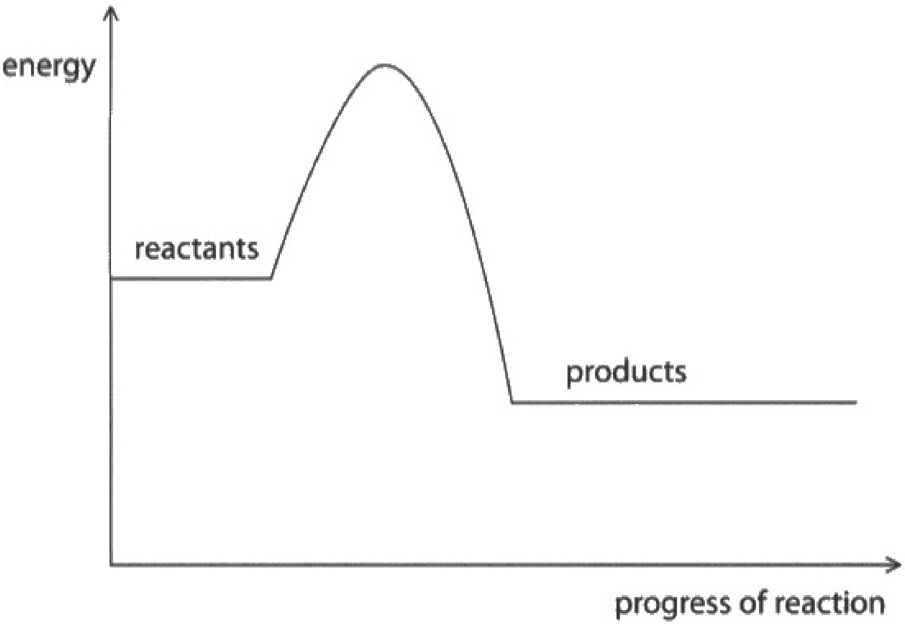


Figure 13

Using some examples of catalysts you have met in chemistry, discuss what catalysts do and their effect on the activation energy of a reaction.

You can use Figure 13 to illustrate your answer.

(6)

Catalyste are things which speed up reactions.

~~They enter something called an a~~

Examples of catalysts are things like tempature, or elements which help speeding up a reaction. Eg when proteins are made they enter an activation site making its production faster.

ResultsPlus
Examiner Comments

There were very few low and no scoring responses given to this question. This is an example of a response that had just enough information to score a mark. The candidate correctly states that catalysts speed up (the rate of) reactions, but does not go on to mention that the catalyst remains at the end of the reaction. There is no mention of activation energy, and the attempts at examples of catalysts are not correct.

Question 10 (a)(i)

Most responses gave the answer as butene rather that but-2-ene, suggesting that a lot of candidates are not aware of the isomers of butene.

Question 10 (a)(ii)

This question usually scored either two or zero marks. Where candidates got the product formula correct then they inevitably got the whole equation correct, however, it seemed addition reactions were another area of chemistry that candidates were unfamiliar with. Many candidates added extra products to the equation like water or hydrogen and a significant minority of candidates gave the formula of bromine as Br.

(ii) Complete the balanced equation for the reaction of hydrocarbon **Z**, C_4H_8, with bromine.

(2)

C_4H_8 + ...Br_2...... → ......$C_4H_8Br_2$......

ResultsPlus
Examiner Comments

This candidate has given the correct formula for the product and for bromine and therefore scored both marks.

(ii) Complete the balanced equation for the reaction of hydrocarbon **Z**, C_4H_8, with bromine.

(2)

C_4H_8 + ...$2Br$...... → ......$2C_2H_4Br$......

ResultsPlus
Examiner Comments

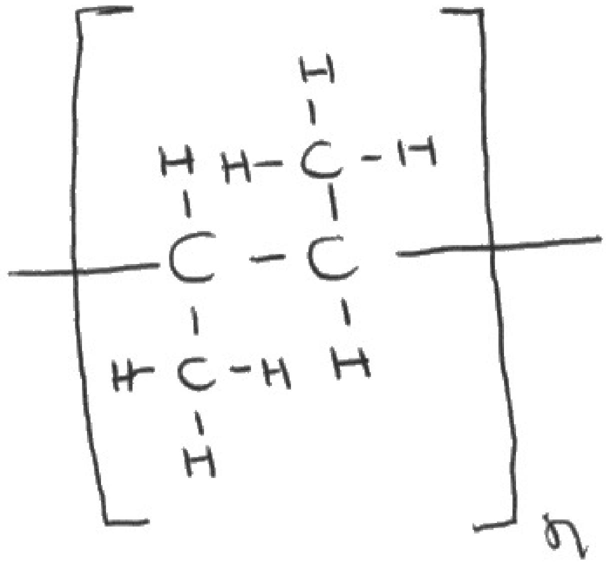
This was a good attempt, but unfortunately did not score. The product molecule that has been suggested by the candidate does not exist, and they have also missed that bromine is a diatomic molecule.

Question 10 (a)(iii)

Addition polymerisation remains a challenge to the majority of candidates and this response did not score well at all. The most common answer seen showed a repeating unit with a chain of four carbons rather than two carbons with two methyl groups. Many candidates included a double bond in their answer, and some did not include four bonds per carbon atom either settling for five or three and leaving out continuation bonds altogether.

(iii) Draw the repeating unit of the addition polymer formed when hydrocarbon **Z** undergoes polymerisation.

(2)

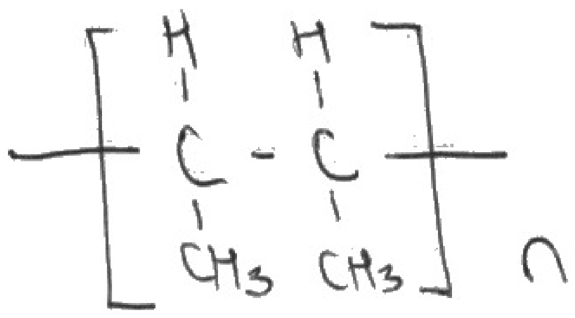


ResultsPlus
Examiner Comments

A rare example of a fully correct answer. Continuation bonds are shown in the correct place and all displayed bonds are correct.

(iii) Draw the repeating unit of the addition polymer formed when hydrocarbon **Z** undergoes polymerisation.

(2)

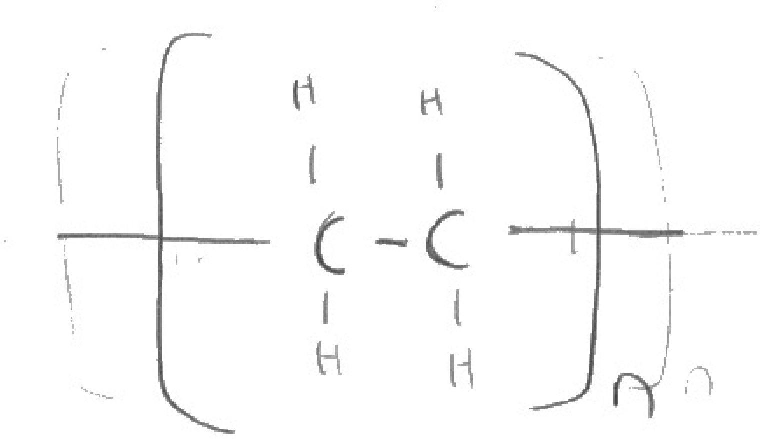


ResultsPlus
Examiner Comments

Full marks could also be scored by showing the methyl groups without their structural formulae as long as each methyl group was attached to a different carbon atom.

(iii) Draw the repeating unit of the addition polymer formed when hydrocarbon **Z** undergoes polymerisation.

(2)

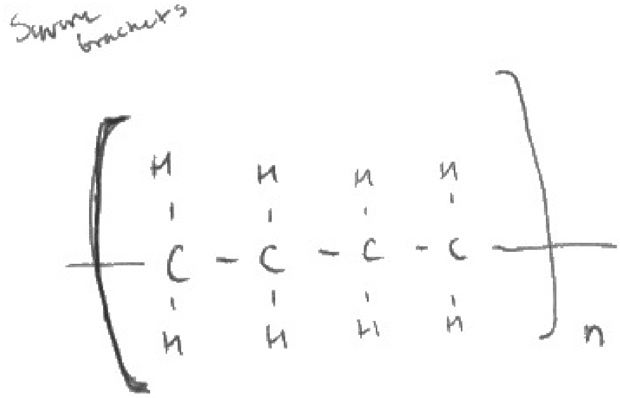


ResultsPlus
Examiner Comments

Candidates could score one mark if they correctly drew two carbon atoms in a chain, with continuation bonds and anything else added to the other bonds. In this case the candidate has drawn the repeating unit of poly(ethene).

(iii) Draw the repeating unit of the addition polymer formed when hydrocarbon **Z** undergoes polymerisation.

(2)



ResultsPlus
Examiner Comments

This was the most commonly seen incorrect response, with candidates showing a four carbon chain including continuation bonds, rather than a two carbon chain with two methyl groups.

Question 10 (b)(i)

This question was surprisingly poorly answered and another indication that candidates knowledge of organic chemistry was weaker than other parts of the specification.

Question 10 (b)(ii)

Another question that was not well answered overall. The majority of candidates did not seem to know that the product formed would be a carboxylic acid. Some that did know it was a carboxylic acid wrote 'carboxylic acid' instead of the formula for the carboxyl group or gave the formula for the whole molecule rather than just the functional group. Other candidates gave a variety of different functional groups in their answers, a common one being C_nH_{2n+2}.

(ii) Give the formula of the functional group of the product formed when the alcohol in Figure 15 undergoes oxidation.

(1)

Carboxylic acids

ResultsPlus
Examiner Comments

This response has correctly identified that the product will be a carboxylic acid, but not given the formula of the functional group that was asked for in the question.

(ii) Give the formula of the functional group of the product formed when the alcohol in Figure 15 undergoes oxidation.

(1)

COOH

ResultsPlus
Examiner Comments

A correct answer giving the formula of the functional group in carboxylic acids.

Question 10 (b)(iii)

Most candidates correctly identified the problem being with the polystyrene cup with the most common answer being that it would melt or catch fire, or that it was an insulator and the water would not heat up.

Some candidates discussed the lack of a stand and clamp (which is not required in a diagram) and others stated that the balance was not necessary or that the burner should be on the balance during the experiment. A few seemed to think that there was no lid on the cup, even though it was clearly visible.

(iii) A student wants to investigate the amount of energy released when 1.00 g of the alcohol is burned.

They set up the apparatus shown in Figure 16 to measure the temperature rise of the water.

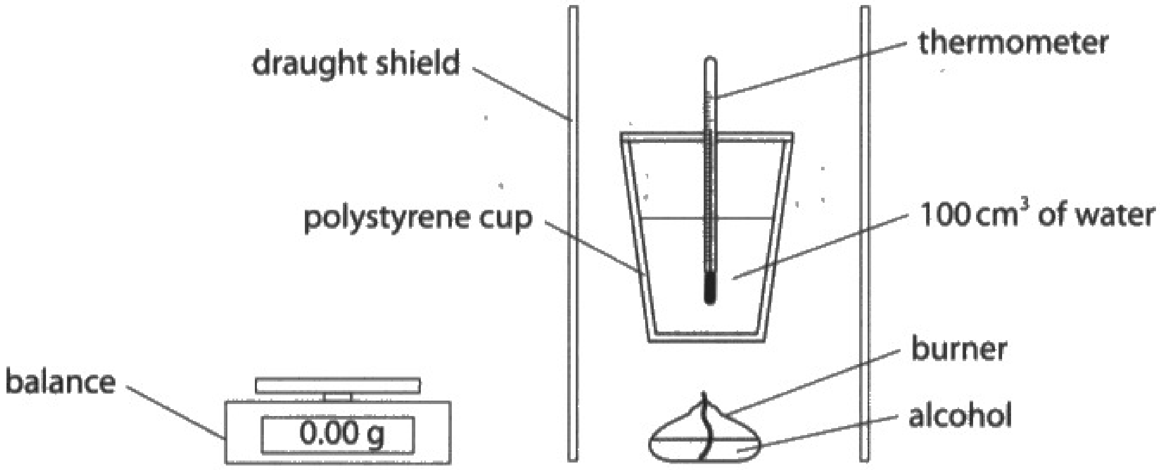


Figure 16

State why this apparatus is not suitable for use in this experiment.

(1)

polystyrene cup is flammable

ResultsPlus Examiner Comments

An example of the most common correct answer.

(iii) A student wants to investigate the amount of energy released when 1.00 g of the alcohol is burned.

They set up the apparatus shown in Figure 16 to measure the temperature rise of the water.

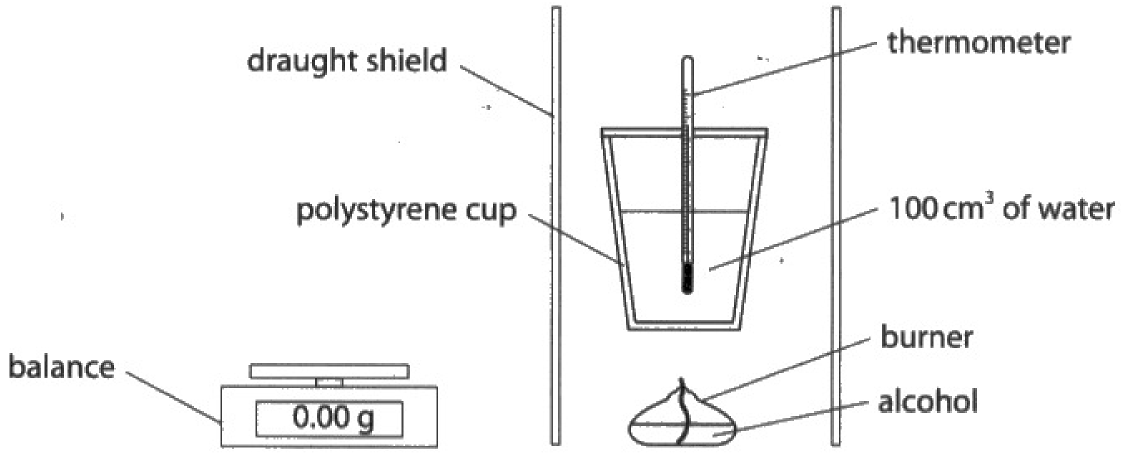


Figure 16

State why this apparatus is not suitable for use in this experiment.

(1)

there is no tripod and gauze to hold up the cup

ResultsPlus
Examiner Comments

A number of incorrect responses referred to the lack of equipment supporting the cup on the diagram. Others suggested that the balance wasn't in the right place or not necessary.

Question 10 (c)(i)

Condensation polymerisation is specific to higher tier chemistry, and it appears that candidates do not know or understand very much about the process. Approximately half of the responses correctly identified water with a variety of alternative suggestions including carbon dioxide, hydrogen and various hydrocarbons.

Question 10 (c)(ii)

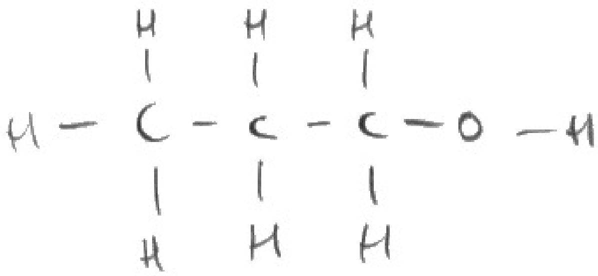
Some candidates correctly identified a molecule containing a chain of three carbons and scored one mark. Most of these responses also included the – OH group (as the question stated an alcohol). Only a very few responses correctly identified that the alcohol should be a diol.

Common incorrect responses included molecules with double bonds or containing an ester link.

(ii) Draw the structure of one molecule of the alcohol used to produce the polyester shown in Figure 17, showing all covalent bonds.

(2)

Formula for alcohol $= C_nH_{2n+2}O$

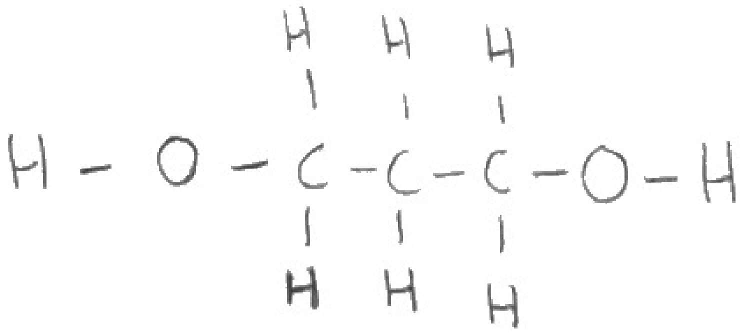


ResultsPlus
Examiner Comments

This response scored one mark for correctly showing a molecule containing a chain of three carbon atoms. As it only shows one functional group the second mark was not to be awarded.

(ii) Draw the structure of one molecule of the alcohol used to produce the polyester shown in Figure 17, showing all covalent bonds.

(2)



ResultsPlus
Examiner Comments

This response scored both marks. One for recognising that the alcohol would contain three carbons, and the other for the two functional groups.

ResultsPlus
Examiner Tip

Condensation polymers are formed from monomers that contain two functional groups.

Paper Summary

Based on their performance in this paper, candidates should:

- Observe and carry out detailed practical investigations. The experiment is only part of the practical, and skills like equipment selection, recording observations and forming conclusions are not always well demonstrated.
- Practice and use the correct scientific language. Focus on the difference between atoms, ions and molecules and the name changes from element to anion.
- Get more experience with calculations using Avogadro's number in order to understand the difference between molar quantities of atoms, molecules and ions.
- Be able to explain the displacement reactions of the halogens in terms of observations and redox, and to appreciate the difference between halogen molecules and halide ions.
- Know the difference between empirical and molecular formula.
- Carry out practical investigations on testing for cations and anions, understanding the procedures and results.
- Set out calculations clearly, showing all working out.
- Increase focus on organic chemistry, including different homologous series and polymerisation.
- Recognise different types of reactions such as dehydration and oxidation and how these reactions change organic molecules.
- Explain differences in the formation of addition and condensation polymers.
- Focus on the meaning of the different command words, particularly describe and explain.

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