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Examiners' Report
June 2023

Int GCSE Chemistry 4CH1 1CR

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June 2023

Publications Code 4CH1_1CR_2306_ER

Introduction

This paper discriminated well and gave a range of marks over all grades. The paper was well balanced, with accessible marks on all questions. The calculations on this paper performed better than expected, which was understandable as overseas candidates often have good mathematical skills and are not handicapped by the language barrier which was sometimes apparent on the longer questions. Explanations and descriptions were variable with some very good answers, but some lost unnecessary marks as they were often too vague when writing their answers. It was apparent that many candidates had done very little practical work as questions involving practical work and demonstrations tended to score lower marks than more theoretical questions.

Question 1 (a)(i)

The arrangement of gas particles was well understood and a large majority of candidates drew a correct random arrangement of particles. Very few drew a regular structure or had more than two particles touching each other.

Question 1 (a)(ii)

The majority stated that the particles were closer together or more dense. Note that there must be a comparison when answering the question. Just stating that they were close was not enough to gain the mark.

Question 1 (a)(iii)

Overall, this question was not particularly well answered. A very common answer was to state that oxygen was flammable. This was ignored as oxygen is not flammable. A surprising number thought that oxygen was toxic. The most common correct answers were to mention risk of explosion or high pressure.

Question 1 (b)(i)

This question was poorly answered, as only a small minority knew that sulfur burned with a blue flame. It was apparent that many centres had not observed sulfur burning.

Question 1 (b)(ii)

The majority knew that the universal indicator would be red, orange or yellow. Most then went on to say that sulfur dioxide is acidic, which was an allowable answer. Only a small number stated that an acidic solution formed. A surprising number seemed to confuse sulfur with sodium and stated that the universal indicator turned blue or purple as an alkali was formed.

Question 2 (a)

The majority knew that filtration was used to separate sand from water. Some thought simple distillation was used to produce solid sodium chloride, rather than crystallisation and others thought fractional distillation was used to separate water from copper(II) sulfate.

Question 2 (b)

This question was not particularly well answered by the majority. A surprising number thought that diatomic molecules were compounds rather than elements, which showed a lack of understanding. Many referred to particles, atoms or molecules but did not refer to different substances or elements and so did not gain credit.

Question 2 (c)

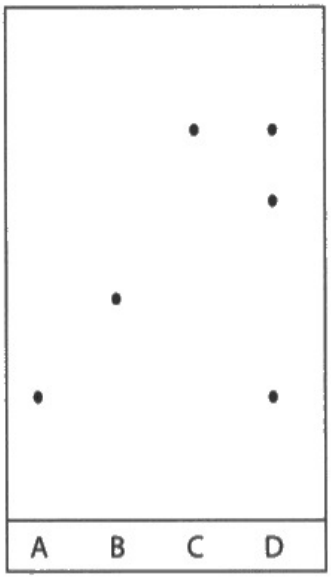
Most candidates scored at least 1 mark for this question.

(c) Food colourings are mixtures of food dyes.

A student uses paper chromatography to separate the food dyes contained in food colouring D.

The student places spots of three food dyes A, B and C and food colouring D on chromatography paper.

The diagram shows the appearance of the paper after the experiment.



Describe the composition of food colouring D.

(2)

The food colouring D contains food dye A and C, and has an unknown food dye of Rf value between that of B and C.

ResultsPlus
Examiner Comments

This is a clear answer that states that D contains food dye A and C and also has an unknown food dye.

ResultsPlus
Examiner Tip

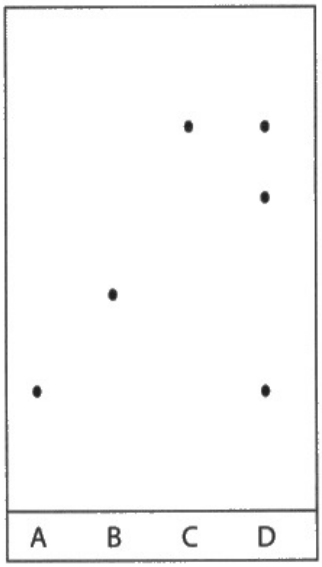
The question asks for a description of the composition, so you need to refer to the three spots and which food dyes are present.

(c) Food colourings are mixtures of food dyes.

A student uses paper chromatography to separate the food dyes contained in food colouring D.

The student places spots of three food dyes A, B and C and food colouring D on chromatography paper.

The diagram shows the appearance of the paper after the experiment.



Describe the composition of food colouring D.

(2)

There are three dyes which means there are three substances in D are dissolve in the st solvent. The highest dye are most suitible to dissolve in this solvent.

ResultsPlus
Examiner Comments

The candidate gained 1 mark for stating that there were 3 dyes, but there was no reference relating to the positions of the spots.

ResultsPlus
Examiner Tip

In order to gain the second mark, the candidate must have either stated that dyes A and C were present or that there was an unknown dye or that dye B was not present.

Question 3 (a)(iii)

Most candidates realised that they had the same number of protons and electrons. Some, however, talked about electrons having a charge of –1 and protons having a charge of +1, but did not always specify the equal number of protons and electrons, so did not score the mark.

Question 3 (b)(i)

This was not well answered by many candidates. A surprising number referred to the number of protons rather than the number of electrons, which was not creditworthy as the reactions depend on the electrons. Many stated that they had the same number of electrons in the outer shell, which was ignored as they needed to state that the isotopes had the same number of electrons.

Question 3 (b)(ii)

The majority of candidates scored all 3 marks for this calculation. A few candidates lost the third marking point for not giving the answer to two decimal places.

(ii) A sample of lithium contains 7.60% $^{6}_{3}Li$ and 92.4% $^{7}_{3}Li$

Calculate the relative atomic mass, A_r, of this sample of lithium.

Give your answer to two decimal places.

(3)

$= \frac{7.60 \times 6 + 92.4 \times 7}{100} \times 100$

$= \frac{45.6 + 646.8}{100} \times 100$

$= 692.4$

$=$

$A_r = 692.4$

ResultsPlus
Examiner Comments

The answer scored 1 mark for a correct multiplication and addition. However, they divided by 100 but also multiplied by 100 which was a contradiction, so the second marking point did not score. Also, the answer was not given to two decimal places so the third marking point could not be awarded.

ResultsPlus
Examiner Tip

An unnecessary mark was lost by not reading the question carefully enough, as the third mark could have been awarded for giving the answer to two decimal places.

(ii) A sample of lithium contains 7.60% $^{6}_{3}Li$ and 92.4% $^{7}_{3}Li$

Calculate the relative atomic mass, A_r, of this sample of lithium.

Give your answer to two decimal places.

(3)

$$\frac{(7.60 \times 6) + (92.4 \times 7)}{100}$$

$= 6.924$

$= 6.92$

$A_r = 6.92$

ResultsPlus
Examiner Comments

This is a clear concise answer which scores all three marks.

ResultsPlus
Examiner Tip

Always show your working as, if a mistake is made, errors can always be carried forward.

Question 4 (a)

Many candidates scored 3 or 4 marks for this question by choosing the answers from the box. The most common mistake was to think that carbon dioxide was produced from the fractional distillation of crude oil, rather than methane.

Question 4 (b)(i)

A fair number of candidates lost the mark for stating that copper was oxidised, but did not give the name or formula of copper oxide.

Question 4 (b)(ii)

The minority did realise that the gas expands when it is hot, but many just stated to make sure that the reaction had finished, which was not creditworthy.

Question 4 (b)(iii)

This question was very well answered by the majority of candidates.

(iii) At the start of the experiment, the total volume of air in the apparatus is 138 cm^3.

At the end of the experiment, the volume of gas remaining is 108 cm^3.

Calculate the percentage of oxygen in the sample of air.

Assume that all the oxygen has reacted.

(2)

$$\frac{108}{138} \times 100$$

$$= 78.3\%$$

percentage of oxygen = 78.3 %

ResultsPlus
Examiner Comments

This candidate found the percentage of the gas remaining, rather than the percentage of oxygen in the air. However, 1 mark was awarded for knowing how to find a percentage.

ResultsPlus
Examiner Tip

It is useful to underline the data in the question to help construct your answer.

(iii) At the start of the experiment, the total volume of air in the apparatus is 138 cm^3.

At the end of the experiment, the volume of gas remaining is 108 cm^3.

Calculate the percentage of oxygen in the sample of air.

Assume that all the oxygen has reacted.

(2)

138 - 108 = 30

percentage of oxygen = 30 %

ResultsPlus
Examiner Comments

This candidate found the volume of oxygen correctly but did not go on to find the percentage.

ResultsPlus
Examiner Tip

It is worth noting that there needs to be two steps to a calculation for a 2-mark question.

(iii) At the start of the experiment, the total volume of air in the apparatus is 138 cm^3.

At the end of the experiment, the volume of gas remaining is 108 cm^3.

Calculate the percentage of oxygen in the sample of air.

Assume that all the oxygen has reacted.

(2)

138 - 108

= 30

$\frac{30}{138} \times 100\%$

= 21.7 %

percentage of oxygen = 21.7 %

ResultsPlus
Examiner Comments

Working was clearly shown and the correct answer was written on the answer line.

ResultsPlus
Examiner Tip

Always show your working, as if you make a mistake a mark could still be given for error carried forward.

Question 5 (a)(i)

The majority of candidates knew that water and oxygen caused rusting and gained both marks. A small minority wrote carbon dioxide rather than oxygen.

Question 5 (a)(ii)

Most wrote oxidation or a few wrote redox which was allowed.

Question 5 (b)(i)

Most knew that paint stopped the reaction with oxygen and water, but many failed to mention the barrier method. Some candidates did not read the question carefully enough and discussed zinc rather than painting.

(b) Iron can be prevented from rusting by painting or by coating with zinc.

(i) Explain how painting prevents iron from rusting.

(2)

painting / paint acts as a barrier and prevents water / moisture and oxygen / air from reaching the iron. Stops reaction from occurring.

ResultsPlus
Examiner Comments

This candidate gave a clear answer and scores both marks. They knew it was a barrier method and how it stopped iron from reacting with water and oxygen.

ResultsPlus
Examiner Tip

Underlining painting focused the question relating to the barrier method.

(b) Iron can be prevented from rusting by painting or by coating with zinc.

(i) Explain how painting prevents iron from rusting.

(2)

The paint prevents ~~air~~ oxygen and water from coming into contact and reacting with the iron stops O_2 and H_2O from reacting with the iron

ResultsPlus
Examiner Comments

No mention of the barrier method, but this candidate knew that oxygen and water stopped the reaction with iron so gained 1 mark.

ResultsPlus
Examiner Tip

As an explanation is required, the candidate needs to mention how the paint stops contact with the iron by reference to a barrier or protective layer.

Question 5 (b)(ii)

Galvanising was well known by many, but some wrote sacrificial protection, which was ignored.

Question 5 (b)(iii)

Most gained the first mark, but some did not give a comparison or lost the second mark for stating that zinc rusts.

(iii) Explain why a layer of zinc protects iron from rusting, even if the layer of zinc is scratched.

(2)

As zinc is more reactive that iron, zinc will react with the oxygen and water before iron.

ResultsPlus
Examiner Comments

This is a clear concise answer which gains both marks.

ResultsPlus
Examiner Tip

A comparison is needed to gain the second mark. If 'before iron' was omitted, the second mark would not have scored.

Question 5 (c)(i)

The majority of candidates gained both marks here, but a few lost the second mark by not mentioning that iron was displaced.

(c) Iron is formed when aluminium reacts with iron(III) oxide.

This is the equation for the reaction.

oxidised reduced

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

(i) Explain what this reaction shows about the relative reactivities of aluminium and iron.

(2)

Aluminium is more reactive than iron as it displaced iron to form Al_2O_3

ResultsPlus
Examiner Comments

A clear concise answer which gains both marks.

ResultsPlus
Examiner Tip

Underlining key words can help focus the answer.

(c) Iron is formed when aluminium reacts with iron(III) oxide.

This is the equation for the reaction.

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

(i) Explain what this reaction shows about the relative reactivities of aluminium and iron.

(2)

Aluminium is more reactive than iron as it snatches the oxygen from the iron.

ResultsPlus
Examiner Comments

The first mark is gained, but 'snatches the oxygen from the iron' is insufficient for the second mark.

ResultsPlus
Examiner Tip

This is a displacement reaction, so the word 'displaces' is required to gain the second mark.

Question 5 (c)(ii)

Many candidates lost the first marking point by not stating that iron(III) oxide was the oxidising agent. A few did state that iron was the oxidising agent, which was not correct but they were able to gain the second mark by stating that aluminium was oxidised.

(ii) **Explain which substance acts as an oxidising agent in this reaction.**

(2)

- ~~2Al~~ Fe_2O_3 is acting as an oxidising agent
- Because it has oxidised 2Al (gave oxygen) and itself was reduced

ResultsPlus
Examiner Comments

This candidate identified the oxidising agent correctly and has oxidised aluminium, which is enough for the second mark.

ResultsPlus
Examiner Tip

If the formula is given rather than the name, the formula must be correct. Usually safer to use the name.

(ii) Explain which substance acts as an oxidising agent in this reaction.

(2)

Iron acts as an oxidising agent as it gives away oxygen to Aluminium and gets reduced.

ResultsPlus Examiner Comments

Iron is not the oxidising agent, but the second mark can be awarded for giving away oxygen to aluminium.

ResultsPlus Examiner Tip

Strictly speaking it is the Fe^{3+} ions that are the oxidising agent but, as this is a near miss, the second mark can be awarded.

(ii) Explain which substance acts as an oxidising agent in this reaction.

(2)

Aluminium is acting as an oxidising agent because it loses 2 electrons and gets oxidised.

ResultsPlus Examiner Comments

As aluminium is the reducing agent no marks can be awarded for stating that aluminium is the oxidising agent, even if there is a mention of aluminium losing electrons.

ResultsPlus Examiner Tip

Aluminium becomes oxidised so it cannot be the oxidising agent.

Question 6 (a)

Only the minority of candidates stated that air was present in the flask. The majority thought that water vapour or hydrogen was mixed with the oxygen, which was not creditworthy.

Question 6 (b)

Approximately half the candidates gained both marks, but many candidates just stated that a catalyst speeds up the reaction, which does not answer the question and is not creditworthy.

(b) The rate of reaction can be increased by adding a catalyst to the hydrogen peroxide solution.

Describe how a catalyst increases the rate of a reaction.

(2)

provides an alternate pathway with a lower activation energy for the reaction to occur.

ResultsPlus
Examiner Comments

This is a concise answer which describes how a catalyst increases the rate of reaction.

ResultsPlus
Examiner Tip

When describing **how** a catalyst works, the candidate must state that the activation energy is lowered and that there is an alternative route or pathway.

(b) The rate of reaction can be increased by adding a catalyst to the hydrogen peroxide solution.

Describe how a catalyst increases the rate of a reaction.

(2)

Catalysts increases reactions without being used or used up in the reaction.

ResultsPlus
Examiner Comments

This does not describe how a catalyst works so just stating that the catalyst is not used up is not creditworthy.

ResultsPlus
Examiner Tip

Just stating that the catalyst increases the rate of reaction is not creditworthy as this is just repeating the stem.

Question 6 (c)

This question discriminated very well, giving a full range of marks.

(c) These solids catalyse the decomposition of hydrogen peroxide solution.

- lead(IV) oxide
- manganese(IV) oxide

Describe a method that the student could use to find out which solid is the more effective catalyst.

(5)

Pour the same volume of ~~hy~~ hydrogen peroxide solution with the same ~~concentra~~ concentration into each ~~beaker~~ flask. Once ~~add~~ added, place in the same ~~mass~~ mass of lead (IV) oxide in a flask and manganese (IV) oxide into another. Cover each flask with a bung and start a timer for 10 minutes. Use a gas syringe to collect the ~~oxygen~~ oxygen and to measure the volume. After 10mins, remove the gas syringe and compare the 2 volumes. The flask with more oxygen released contains the more ~~effe~~ effective catalyst. Repeat the experiment atleast 3 times ~~for~~ for more accurate ~~results~~. & results.

ResultsPlus
Examiner Comments

This is a clear 5 mark answer.

The description of the experiment describes adding the same volume of hydrogen peroxide and same masses of the catalysts and states that the volume of oxygen produced in a fixed time. It also states that the one with the more oxygen produced is the most effective catalyst.

ResultsPlus
Examiner Tip

When describing a method, use logical steps and control the variables in the experiment.

(c) These solids catalyse the decomposition of hydrogen peroxide solution.

- lead(IV) oxide
- manganese(IV) oxide

Describe a method that the student could use to find out which solid is the more effective catalyst.

(5)

- Start a stop watch once you Add lead (IV) oxide to the solution.
- Measure the time taken to collect 20cm^3 of oxygen in the gas syringe.
- repeat this 3 times to find an average time.
- Then repeat this 3 more times using manganese (IV) oxide. Find an average.
- Whichever has the lowest average time ~~does~~ is the more effective catalyst.

ResultsPlus
Examiner Comments

This is a good description of the experiment, but unfortunately there are no controls mentioned so the answer is limited to 3 marks.

ResultsPlus
Examiner Tip

When describing an experiment, you should use the same amounts of substances and keep the temperature constant, otherwise it will not be a fair test.

(c) These solids catalyse the decomposition of hydrogen peroxide solution.

- lead(IV) oxide
- manganese(IV) oxide

Describe a method that the student could use to find out which solid is the more effective catalyst.

(5)

preparing a ~~stopwatch~~ stopwatcher. Putting lead oxide in the ~~water~~ H_2O_2, using stopwatcher to record the time that the whole reaction takes. Doing that ~~ag~~ again with the manganese oxide recording the time of entire react. Then, comparing the two record. The faster one will be more effective.

ResultsPlus
Examiner Comments

Just 1 mark for adding the catalyst to the hydrogen peroxide.

Just stating 'the time the whole reaction takes' is too vague. Just stating 'the faster one will be more effective' is also too vague. There must be some indication that either a greater volume is produced in a fixed time, or a shorter time is needed to produce a fixed volume of oxygen.

ResultsPlus
Examiner Tip

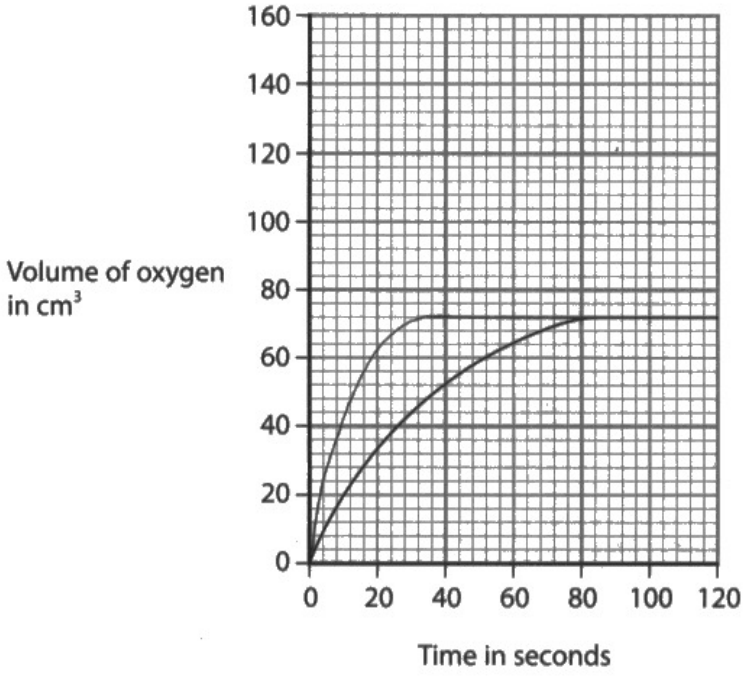
Vague statements are not really describing the experiment and if there are no controls, it will not be a fair test.

Question 6 (d)

Many gained at least 1 mark for starting at the origin and drawing a steeper curve. Most also gained the second mark for levelling it off at the same volume, but some lost the second mark for showing a higher volume. A small minority sometimes lost a mark for not starting at the origin.

(d) A student investigates the decomposition of a solution of hydrogen peroxide at different temperatures.

The graph shows how the total volume of oxygen collected in the syringe changes with time when the solution is at a temperature of 20 °C.



On the grid, draw the curve the student would obtain at a temperature of 40 °C when all other conditions are kept the same.

(2)

ResultsPlus
Examiner Comments

A good 2 mark answer showing a clear smooth steeper curve starting at the origin and levelling off at the same volume.

ResultsPlus
Examiner Tip

It would be a good idea to use a pencil to draw the curve as if you make a mistake, you can rub it out and start again.

Question 7 (a)

The majority of candidates knew that limewater turned cloudy and stated that carbon dioxide was produced and gained both marks. Only a small number mentioned the third marking point.

Question 7 (b)(i)

Many fully correct answers seen. However, some stopped at dividing 0.12 by 0.01 giving an answer of 12, but were not sure what to do next.

(b) The equation represents the complete combustion of an alkene.

O_2 CO_2 nH_2O

C_nH_{2n} + oxygen → carbon dioxide + nH_2O 2.16g

Complete combustion of 0.0100 mol of the alkene produces 2.16 g of water.

(i) Determine the molecular formula of this alkene.

[for H_2O, $M_r = 18$]

0·12 mol for 0·0100 mol of alkene.

(3)

mol $H_2O = \frac{2.16}{18} = 0.12$ mol

molecular formula = ...

ResultsPlus
Examiner Comments

The candidate gained 1 mark for finding the moles of water. There was some mention of moles of alkene, but this was illegible and not relevant.

ResultsPlus
Examiner Tip

Make sure your working is clear as, if your working is illegible, no marks can be awarded.

(b) The equation represents the complete combustion of an alkene.

$$C_nH_{2n} + \text{oxygen} \rightarrow \text{carbon dioxide} + nH_2O$$

Complete combustion of 0.0100 mol of the alkene produces 2.16 g of water.

(i) Determine the molecular formula of this alkene.

[for H_2O, $M_r = 18$]

12 H_2O

(3)

$\frac{0.12}{0.01}$ = 12

$\frac{2.16}{18}$ = 0.12 mol of H_2O

1 : 12

molecular formula = $C_{12}H_{24}$

ResultsPlus
Examiner Comments

The correct answer on the answer line scores all 3 marks. Clear working is also shown.

ResultsPlus
Examiner Tip

Always show your working as no marks can be awarded if there is no working and the answer on the answer line is incorrect.

Question 7 (b)(ii)

This question was poorly answered as the majority failed to mention water vapour or steam in their answer. Many thought water was lost by evaporation or that incomplete combustion occurred, which was ignored.

Question 7 (b)(iii)

The majority knew that pure water boils at 100°C, but a few lost the first marking point for not describing the test, which involved heating the water. Some used the chemical test which involved addition of anhydrous copper(II) sulfate. Candidates needed to understand that this test contains water, but there is no guarantee that it is pure water.

Question 7 (c)

The majority of candidates gained all 3 marks for this calculation.

(c) The teacher burns 30.0 g of heptane.

This is the equation for the complete combustion of heptane.

$$C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$$

Calculate the minimum mass of oxygen needed for the complete combustion of 30.0 g of heptane.

[for C_7H_{16}, $M_r = 100$ for O_2, $M_r = 32$]

(3)

$n = \frac{\text{mass}}{RMM}$

C_7H_{16} $n = \frac{30.0}{100} = 0.3$

$0.3 = \frac{\text{mass}}{32} =$

$\text{mass} = 0.3 \times 32 = 9.6$

minimum mass of oxygen = 9.6 g

ResultsPlus Examiner Comments

This candidate found the moles of heptane, but ignored the 11 in front of the oxygen and just multiplied the moles of heptane by 32.

ResultsPlus Examiner Tip

When doing a calculation involving moles and masses, make sure you use numbers in front of the equation in your calculation. Although they missed out the second step the third mark was awarded as an error carried forward mark, as clear working was shown.

(c) The teacher burns 30.0 g of heptane.

This is the equation for the complete combustion of heptane.

$$C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$$

Calculate the minimum mass of oxygen needed for the complete combustion of 30.0 g of heptane.

[for C_7H_{16}, $M_r = 100$ for O_2, $M_r = 32$]

(3)

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

$= \frac{30}{100}$

$= 0.3$

1 : 11

0.3 : ?

$0.3 \times 11 = 3.3$

$n \times \text{RAM} = \text{mass}$

$\text{mass} = 3.3 \times 32$

$= 105.6$

minimum mass of oxygen = 105.6 g

ResultsPlus
Examiner Comments

This candidate showed their clear working and wrote the correct answer on the answer line scoring all 3 marks.

ResultsPlus
Examiner Tip

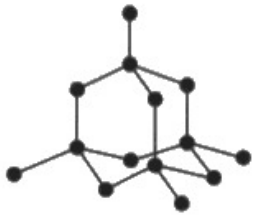
Underline the data in the question and make sure you use the masses and relative formula masses, as well as using the relevant number in the equation.

Question 8 (a)

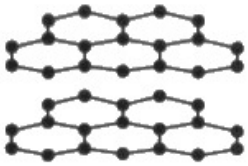
Many good answers. Only some candidates missed the word 'delocalised', but most knew that electrons were responsible for the conduction of electricity. Very few mentioned ions in graphite, which was good to know.

8 Diamond, graphite and C_{60} fullerene are all forms of the element carbon.

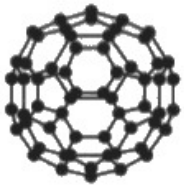
The diagram shows the structures of these three substances.



diamond



graphite



C_{60} fullerene

(a) Explain why graphite conducts electricity.

(2)

It contains delocalised electrons which are free to move and conducts electricity.

ResultsPlus
Examiner Comments

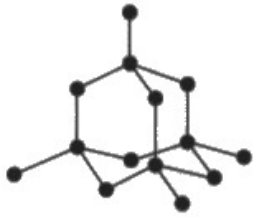
A clear concise answer which gains both marks.

ResultsPlus
Examiner Tip

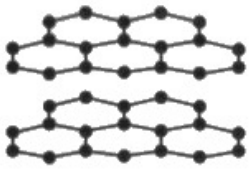
You need to mention delocalised electrons and state that they move to gain both marks.

8 Diamond, graphite and C_{60} fullerene are all forms of the element carbon.

The diagram shows the structures of these three substances.



diamond



graphite

C_{60} fullerene

(a) Explain why graphite conducts electricity.

(2)

only 3 out of 4 electrons are used in bonding so there is ~~one~~ valance electron which lets electricity flow through it.'

ResultsPlus
Examiner Comments

It is true that there are only 3 out of 4 electrons in bonding, but the fourth electron is a delocalised electron, not a valence electron and there is no mention of the electrons moving, so no marks can be awarded.

ResultsPlus
Examiner Tip

You must mention electrons moving or flowing. It is not sufficient to state that electricity flows through it.

Question 8 (b)

Only the minority of candidates gained both marks. The second mark was awarded more often, with reference to layers sliding over each other. A few mentioned intermolecular forces in diamond which lost them the first marking point.

(b) Explain why diamond is hard but graphite is soft.

(2)

Because the structure of diamond is every stable, ~~but the graphite~~. the force in the bonding is strong and it is giant ~~covalent~~ structure. The graphite have layer structure., only weak force between molecule.

ResultsPlus
Examiner Comments

Just stating that diamond is a giant covalent structure is not enough for the mark, as graphite is also a giant covalent structure. It is true that there are weak forces between layers but no mention of sliding over each other so no marks can be awarded.

ResultsPlus
Examiner Tip

You need to refer to the difference between diamond and graphite to score the marks. A rigid, tetrahedral or 3D structure needs to be mentioned or the idea of each carbon being bonded to four others.

delocalised electrons are free to move and can flow to carry current.

(b) Explain why diamond is hard but graphite is soft.

(2)

Diamond structure is tetrahedral structure. The carbon atoms in diamond are arranged in a tetrahedral structure, making it hard while graphite is made of layers with weak forces between the layers so the layers can slide past each other.

ResultsPlus
Examiner Comments

Both marks are awarded here. The answer clearly explains why diamond is hard and graphite is soft.

ResultsPlus
Examiner Tip

Make sure you compare the two structures and explain why they are different.

Question 8 (c)

This question was not well answered. Many referred to structure, conduction of electricity, boiling points, being soft, which were all irrelevant. A few that did score mentioned the molecule being non-toxic, unreactive or inert. An even smaller number referred to the medicine fitting inside the molecule.

Question 9 (a)(i)

Most candidates knew the formula of the calcium ion, but fewer knew the formula of the nitrate ion. A common mistake was to give the charge of 2 – on the nitrate ion.

Question 9 (a)(ii)

Some good 4 mark answers, but marks were often lost by reference to intermolecular forces or not referring to structure or mentioning more energy.

(ii) Explain why calcium nitrate has a high melting point.

Refer to structure and bonding in your answer.

(4)

AS $Ca(NO_3)_2$ is a giant ionic structure, it has ~~strong~~ strong ionic bonds, ~~which~~ which are formed by the ele electrostatic forces of attraction between ~~ion~~ oppositely charged ions ~~particle~~. Lots of energy is needed to overcome ~~their~~ these forces of attractions. Hence the high melting point

ResultsPlus
Examiner Comments

This is a clear concise answer which gains all 4 marking points.

ResultsPlus
Examiner Tip

Make sure you refer to both structure and bonding in your answer.

(ii) Explain why calcium nitrate has a high melting point.

Refer to structure and bonding in your answer.

(4)

Calcium nitrate is giant ~~metal~~ ionic bonding. The electro -stastic attraction is strong, so more energy is required to break the bond.

ResultsPlus
Examiner Comments

The candidate mentions giant ionic bonding, which is not creditworthy as it needs to refer to giant ionic lattice or giant ionic structure. The second mark is awarded for 'electrostatic attraction is strong', but there is no mention of the oppositely charged ions. Stating that 'more energy is required' is ignored, as this is not a comparison, so they must state that a lot of energy is needed to break the bonds.

ResultsPlus
Examiner Tip

As this is an ionic structure, make sure you do not mention covalent bonding or intermolecular forces as they are not present in an ionic structure and marks will be lost.

Question 9 (a)(iii)

A fair number of correct answers were seen, but many candidates struggled to balance the equation and a few added state symbols instead of balancing the equation.

Question 9 (b)

Some very good 6 mark answers were seen. Candidates sometimes lost marks by forgetting to acidify the solutions or for stating the colours correctly, but not mentioning the precipitates. Some used incorrect reagents and sodium hydroxide was mentioned quite often. There was some confusion with bromine and chlorine instead of bromide and chloride and the idea of litmus paper being bleached by chlorine was sometimes seen.

(b) A student has four unlabelled beakers, each containing a colourless solution of a different salt.

These are the four salt solutions.

- calcium bromide
- calcium chloride
- sodium chloride
- sodium sulfate

Describe a series of tests to identify each solution.

Do not refer to safety precautions in your answer.

(6)

To test for sodium and calcium ions, dip a long nichrome wire (to avoid contamination) in HCl, and conduct a flame test. If the flame is orange-red, calcium ions are present. If the flame is yellow, sodium ions are present.

To test for halogens (bromide and chromide), add dilute nitric acid and then add silver nitrate. If there is a white precipitate, chloride ions are present. If there is a cream precipitate, bromide ions are present.

To test for sulfate ions, add dilute nitric acid then barium chloride. If there is a white precipitate, sulfate ions are present.

This is a clear and concise answer which scores all 6 marks.

Plan your answer and give the tests in a logical order.

(b) A student has four unlabelled beakers, each containing a colourless solution of a different salt.

These are the four salt solutions.

- calcium bromide
- calcium chloride CaCl
- sodium chloride NaCl
- sodium sulfate

Describe a series of tests to identify each solution.

Do not refer to safety precautions in your answer.

(6)

1) To test for Calcium bromide, calcium chloride and Sodium chloride:

- Add dilute Nitric acid to the beaker, then add aqueous Silver nitrate

-If Bromine is present an insoluble cream precipitate forms

This means that the beaker has calcium bromide.

-If Chlorine is present an insoluble white precipitate forms

This means that calcium chloride or Sodium chloride were in the beaker. You can test whether it is calcium or Sodium chloride by conducting a displacement test and proving that Sodium is more reactive than ~~flozing~~ calcium.

To test for Sodium Sulfate you:

-Add nitric acid then add barium nitrate aqueous

-If a white precipitate forms then it is Sodium Sulfate in the beaker. - insoluble.

ResultsPlus
Examiner Comments

This candidate has used the correct tests to distinguish the different anions and given the correct colours of the precipitates. There is some confusion with mention of bromine and chlorine rather than bromide and chloride but only 1 mark is deducted here, but as all 5 of the 4 available marks are present, 4 marks are still gained.

Displacement reactions are not creditworthy as adding sodium to an aqueous solution would be dangerous and would give off hydrogen and no displacement would occur. Flame tests have not been mentioned which limits the answer to 4 marks.

ResultsPlus
Examiner Tip

Make sure you test for both the cations and anions to gain full marks.

(b) A student has four unlabelled beakers, each containing a colourless solution of a different salt.

These are the four salt solutions.

- calcium bromide
- calcium chloride
- sodium chloride
- sodium sulfate

Describe a series of tests to identify each solution.

Do not refer to safety precautions in your answer.

(6)

1) To identify between the sodium solutions and the calcium solution, prepare a flame test, we will be able to identify which is sodium and calcium as sodium burns as a yellow flame while calciums is a red-orange flame.

2) Once we have identified between sodium and calcium we need to identify the chlorides, bromide and sulfates, we can do this by using the solubility rules, in water.

ResultsPlus
Examiner Comments

This candidate identified the cations using the flame test, which scored 2 marks. Solubility rules are irrelevant here as all the solutions are soluble.

ResultsPlus
Examiner Tip

It is a good idea to learn the chemical tests for cations and anions as these are frequently tested.

Question 10 (a)(i)

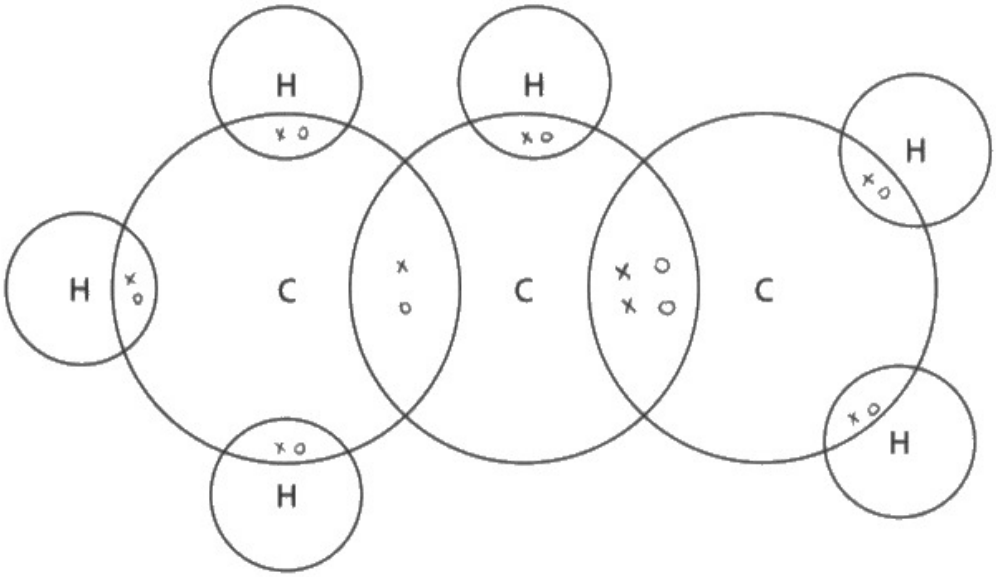
Approximately half the candidates scored both marks for this dot-and-cross diagram. Surprisingly a fair number left it blank, but a few gained 1 mark for the correct pairs of electrons between each C and H.

10 This question is about propene.

(a) (i) The structural formula of propene is $CH_3CH{=}CH_2$

Complete the dot-and-cross diagram for a molecule of propene.

(2)



ResultsPlus
Examiner Comments

A fully correct dot-and-cross diagram scoring both marks.

ResultsPlus
Examiner Tip

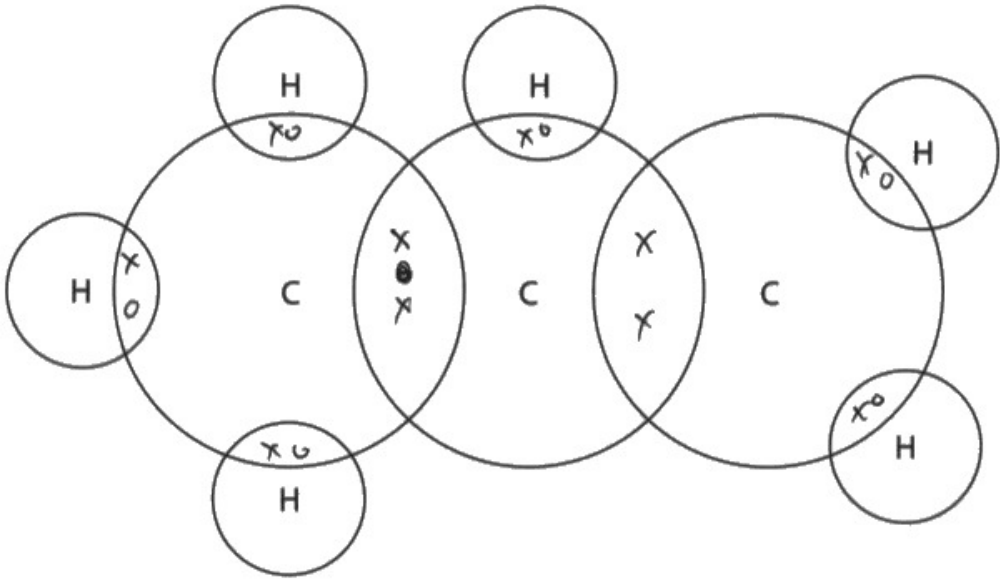
Make sure there are 8 electrons round each of the three carbon atoms.

10 This question is about propene.

(a) (i) The structural formula of propene is $CH_3CH{=}CH_2$

Complete the dot-and-cross diagram for a molecule of propene.

(2)



ResultsPlus
Examiner Comments

A common mistake was to not show the two electron pairs between the second and third carbon atoms. However, 1 mark was awarded for the correct electron pairs between each of the carbon and hydrogen atoms. There are never an odd number of electrons in a dot-and-cross diagram, so three electrons between the first and second carbon is incorrect.

ResultsPlus
Examiner Tip

The structural formula given in the question was to show the double bond, so there must be four electrons in the double bond. Electrons are always in pairs.

Question 10 (a)(ii)

This question was not particularly well answered. Many answers were too vague by just mentioning sharing of electrons, which was not creditworthy.

(ii) **Describe the forces of attraction that hold the atoms together in a molecule of propene.**

(2)

Propene has a covalent bonding. The electron are shared. It has strong covalent bond. Strong intermolecular forces

ResultsPlus
Examiner Comments

There is no mention of a shared pair of electrons and no mention of the electrostatic attraction to the nuclei, so no marks can be awarded. Intermolecular forces are held together between the molecules and not between the atoms.

ResultsPlus
Examiner Tip

A covalent bond is the sharing of a pair of electrons between two **atoms** not between two molecules.

(ii) Describe the forces of attraction that hold the atoms together in a molecule of propene.

(2)

Propene is a covalent ~~bond~~ molecule, so it has ~~the electrons~~ electrostatic forces of attraction between a shared pair of electrons & two nuclei.

ResultsPlus
Examiner Comments

This is a correct answer which scores both marks.

ResultsPlus
Examiner Tip

Learn the definition of a covalent bond as this question is often asked.

Question 10 (b)

Most candidates mentioned cracking so gained 1 mark. Some also often gave the correct temperature range and a suitable catalyst, but others just mentioned high temperature or gave no conditions, which lost them the second mark. A small minority did not read the question carefully enough and referred to fractional distillation or polymerisation instead of cracking.

Question 10 (c)(i)

The majority of candidates drew the correct structure of the polymer and gained both marks. Only a small number lost a mark by omitting the brackets and n. A few candidates included a double bond between the carbons which lost them both marks and showed a lack of understanding.

Question 10 (c)(ii)

Most candidates gained at least 1 mark for this question, but there was quite a lot of unnecessary information relating to toxic gases, greenhouse gases, visual pollution, smells and harming wildlife – all of which was not creditworthy.

(ii) Explain why the disposal of poly(propene) in landfill sites is a problem.

(2)

Poly(propene) is ~~non-biodeg~~ non-biodegradable.
It will stay in the landfill for long time. It won't decompose for long time.

ResultsPlus
Examiner Comments

Both marks are scored here for stating that it was non-biodegradable and stayed in landfill for a long time.

ResultsPlus
Examiner Tip

Poly(propene) and other plastics tend to be unreactive, so this is why there is a problem with filling up landfill. As it is inert, it is unlikely to cause any toxic fumes or produce greenhouse gases.

(ii) Explain why the disposal of poly(propene) in landfill sites is a problem.

(2)

~~It is not biodegradable and~~ combusting polypropene can produce CO and carbon soot which are toxic. As the chain is long and ~~it~~ can easily combusted incompletely.

ResultsPlus
Examiner Comments

This candidate has not read the question properly and has discussed combusting the poly(propene) rather than burying it in landfill. No marks can be awarded.

ResultsPlus
Examiner Tip

Make sure you read the question carefully and discuss the disposal in landfill rather than burning it.

Question 10 (d)(i)

Many fully correct answers seen. Only a small number of candidates gained 1 or 2 marks, with quite a few scoring zero. A few candidates divided by atomic numbers or did an upside-down calculation, which scored zero.

(d) Propene can be converted into compound X.

(i) Compound X contains these percentages by mass.

- carbon 60%
- hydrogen 13.3%
- oxygen 26.7%

Compound X has an M_r of 60

Determine the molecular formula of compound X. (3)

	C	H	O
	$\frac{60}{12}$	$\frac{13.3}{1}$	$\frac{26.7}{16}$
moles	$\frac{5}{1.66875}$	$\frac{13.3}{1.66875}$	$\frac{1.66875}{1.66875}$
ratio	3	8	1

Emperical formula C_3H_8O

Molecular formula = $\frac{60}{60} = 1$

molecular formula = C_3H_8O

ResultsPlus Examiner Comments

This is a fully correct answer showing each step of the working clearly.

ResultsPlus Examiner Tip

The correct molecular formula on the answer line would score all 3 marks, but it is always advisable to show your working as if you make a mistake, you could gain some error carried forward marks.

Question 10 (d)(ii)

This question was poorly answered and proved difficult for many candidates. As the first marking point depended on the reference to intermolecular forces which was not often seen, most scored zero.

(ii) Propene and compound X both have simple molecular structures.

Explain why compound X has a higher boiling point than propene.

(2)

Compound X has larger molecules with a higher mass, because of this, it contains stronger intermolecular forces and requires more energy to be boiled.

ResultsPlus
Examiner Comments

This is a good answer which gains both marks. The candidate states that there are stronger intermolecular forces and more energy is required to boil compound X.

ResultsPlus
Examiner Tip

When you compare two substances, there needs to be a comparison, ie. strong**er** intermolecular forces and **more** energy.

(ii) Propene and compound X both have simple molecular structures.

Explain why compound X has a higher boiling point than propene.

(2)

Because there are more bonds the compound X than in Propene that are from the extra ~~bond~~ covalent bonds.

ResultsPlus
Examiner Comments

This answer scores zero as there is no reference to intermolecular forces.

ResultsPlus
Examiner Tip

When a simple molecular substance boils covalent bonds are **not** broken. It is the intermolecular forces that are broken. If you boil water, it turns into steam and does not produce hydrogen and oxygen as the covalent bonds do not break.

Question 11 (a)

Most candidates plotted the points correctly, drew a smooth curve through the points and circled the anomaly. Some lost points for joining them dot to dot and a few forgot to circle the anomaly.

11 A student uses this method to investigate the temperature change when solid sodium hydrogencarbonate is added to ethanoic acid solution.

- pour 100 cm^3 of ethanoic acid solution into a polystyrene cup
- record the temperature of the ethanoic acid solution
- add a 1 g portion of sodium hydrogencarbonate to the ethanoic acid solution and stir
- record the new temperature
- add further 1 g portions of sodium hydrogencarbonate, stirring and recording the temperature after each portion is added

The table shows the student's results.

Mass of sodium hydrogencarbonate added in g	Temperature in °C
0	20.8
1	19.4
2	18.1
3	18.0
4	16.4
5	15.8
6	15.3
7	15.3
8	15.3

(a) (i) Plot the student's results on the grid.

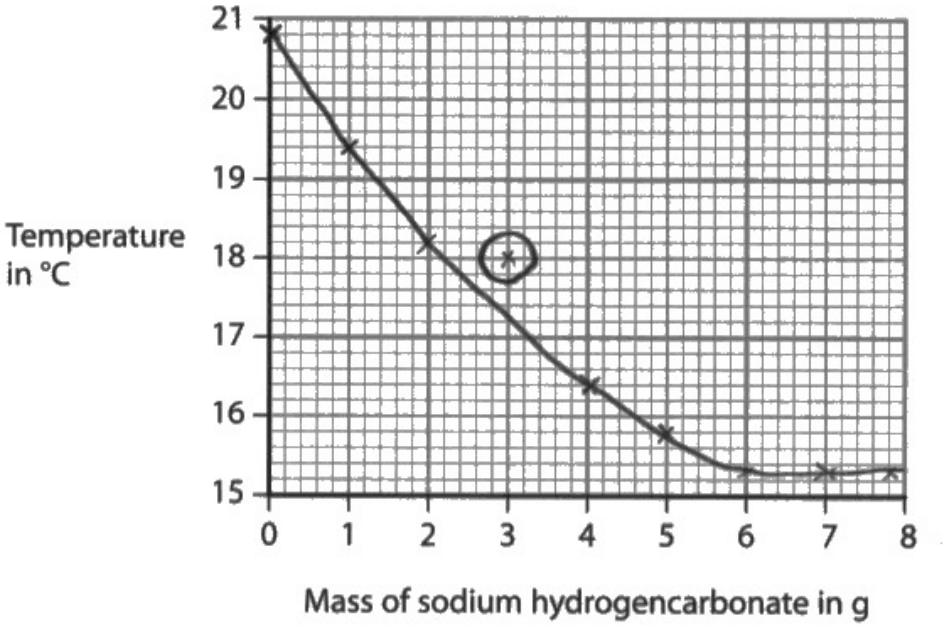
(1)

(ii) Draw a circle around the anomalous result.

(1)

(iii) Draw a curve of best fit.

(1)



ResultsPlus
Examiner Comments

This candidate plotted all the points correctly and drew a smooth curve through the points and circled the anomaly gaining all 3 marks.

ResultsPlus
Examiner Tip

Make sure you draw a smooth curve through the points and leave out the anomaly, but don't forget to draw a circle round the anomaly.

11 A student uses this method to investigate the temperature change when solid sodium hydrogencarbonate is added to ethanoic acid solution.

- pour 100 cm^3 of ethanoic acid solution into a polystyrene cup
- record the temperature of the ethanoic acid solution
- add a 1 g portion of sodium hydrogencarbonate to the ethanoic acid solution and stir
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(a) (i) Plot the student's results on the grid.

(1)

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(1)

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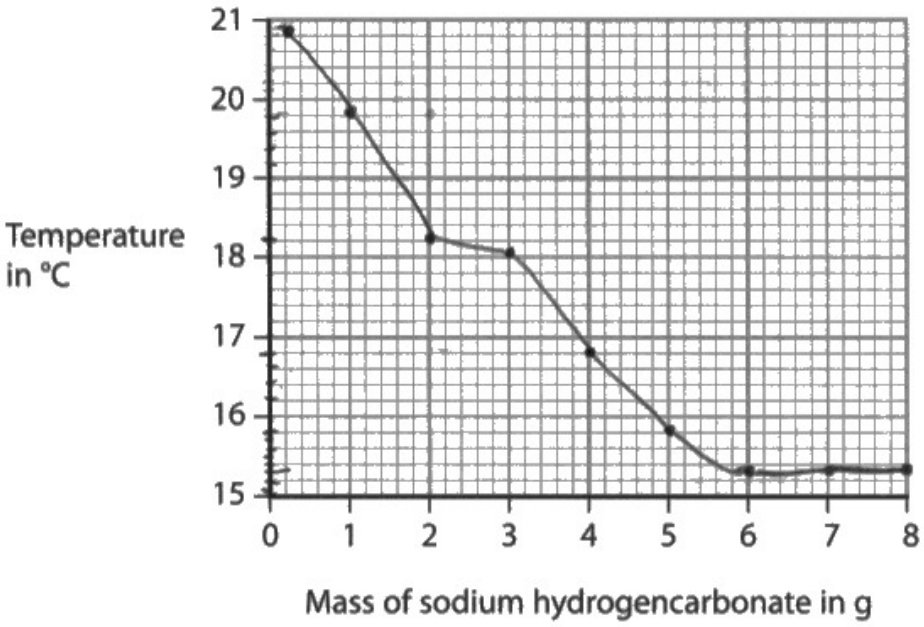
(1)



ResultsPlus
Examiner Comments

This candidate plotted a couple of points incorrectly, joined the points dot to dot and circled the anomaly in the table, which would have been allowed, but unfortunately the wrong anomaly was circled, so no points were awarded.

ResultsPlus
Examiner Tip

When asked to draw a curve of best fit, make sure that it is a smooth curve.

Question 11 (b)(i)

Most candidates scored 1 mark for stating that polystyrene is a good insulator, but only a very small minority realised that heat was absorbed from the surroundings into the cup, so very few candidates scored both marks.

(b) (i) Explain why using a polystyrene cup makes the results more accurate.

(2)

Polystyrene is a good thermal insulator so it prevents heat loss and helps give a more accurate result for temperature.

ResultsPlus
Examiner Comments

This was a very common answer. 1 mark was awarded for stating that polystyrene is a good thermal insulator, but the candidate then stated that it prevents heat loss, so the second mark was not awarded.

ResultsPlus
Examiner Tip

As it is clear that this was an endothermic reaction, heat would not be lost from the cup, instead the polystyrene would stop heat from being absorbed from the surroundings.

Question 11 (b)(ii)

This was not particularly well answered. A significant number of candidates mentioned adding too little sodium hydrogencarbonate, which was rejected, as this would affect the shape of the graph. Those who did score stated that they forgot to stir the mixture or took the temperature too soon, before it had reacted fully.

Question 11 (b)(iii)

Most candidates stated that the temperatures or the results stayed the same and gained the mark. A few stated that the mass stayed the same, which was incorrect as the mass was increasing.

Question 11 (b)(iv)

Most stated that the temperature decreases and some went on to state that heat was taken in or absorbed. Surprisingly, they realised that the reaction was endothermic and heat was absorbed, but they still mentioned heat loss in 11(b)(i). A few thought that heat was lost, which was a contradiction and negated the mark.

Question 11 (c)

Most scored full marks and the equation for Q was well known. A few omitted the 100 in the answer, but most found the correct temperature change so gained the first marking point.

(c) Use the results to calculate the heat energy change, *Q*, in joules.

[for 1.0 cm^3 of ethanoic acid solution, mass = 1.0 g]

[for ethanoic acid solution, c = 4.2 J/g/°C]

(2)

$Q = mc\Delta t$

$= 100 \times 4.2 \times (20.9 - 15.3)$

$= 2310$

$Q =$ 2310 J

ResultsPlus
Examiner Comments

A fully correct answer scoring both marks.

ResultsPlus
Examiner Tip

Remember to learn the equation for Q as this question crops up often.

(c) Use the results to calculate the heat energy change, *Q*, in joules.

[for 1.0 cm^3 of ethanoic acid solution, mass = 1.0 g]

[for ethanoic acid solution, c = 4.2 J/g/°C]

(2)

$Q = mc\Delta H$

$= 1 \times 4.2 \times (20.8 - 15.3)$

$= 1 \times 4.2 \times 5.5$

$= 23.1$ J

Q = 23.1 J

ResultsPlus
Examiner Comments

This candidate found the correct temperature change which scored the first marking point, but failed to look back at the question when 100 cm^3 of ethanoic acid was used and only 1g was given as the mass.

ResultsPlus
Examiner Tip

Don't forget to look back at the question. You would never use only 1 cm^3 of ethanoic acid.

Question 11 (d)

Most candidates scored 3 or 4 marks for this question which discriminated well and gave a range of marks.

(d) The student repeats the experiment starting with a different volume of ethanoic acid solution.

The student uses 7.0 g of sodium hydrogencarbonate to neutralise the ethanoic acid solution.

The heat energy change, Q, is 3200 J.

Calculate the molar enthalpy change, ΔH, in kJ / mol.

Include a sign with your answer.

[for sodium hydrogencarbonate, $M_r = 84$]

(4)

$n = \frac{\text{mass}}{Mr} = \frac{7.0}{84} = 0.083$ moles of sodium hydrogen carbonate

$\frac{3200 \text{ J}}{1000} = 3.2 \text{ kJ}$

$\Delta H = \frac{\text{kJ}}{\text{mol}}$

$\Delta H = \frac{3.2}{0.083} = 38.4$

$\Delta H = \frac{\text{energy in (kJ)}}{\text{moles}} = \frac{\text{kJ}}{\text{mol}}$

$\Delta H =$ + 38.4 kJ / mol

ResultsPlus Examiner Comments

This candidate showed clear working and wrote the correct answer on the answer line, so all 4 marks were awarded.

ResultsPlus Examiner Tip

Remember to convert J to kJ and include the sign in your answer. Always show your working as if you make a mistake, you are likely to gain error carried forward marks.

(d) The student repeats the experiment starting with a different volume of ethanoic acid solution.

The student uses 7.0 g of sodium hydrogencarbonate to neutralise the ethanoic acid solution.

The heat energy change, Q, is 3200 J.

Calculate the molar enthalpy change, ΔH, in kJ / mol.

Include a sign with your answer.

[for sodium hydrogencarbonate, $M_r = 84$]

(4)

$\Delta H = Q / \text{moles}$

$n = m / m_r$

$= 7 / 84$

$= 0.083$

$3200 / 0.083333$

$= 38400$

$\Delta H =$ 38400 kJ / mol

ResultsPlus
Examiner Comments

This candidate found the moles correctly and divided Q by the moles, gaining 2 marks. However, the other 2 marking points were lost as there was no conversion to kJ and no sign on the answer line.

ResultsPlus
Examiner Tip

Always include a sign in your answer even if it is a positive value and make sure you convert J to kJ.

(d) The student repeats the experiment starting with a different volume of ethanoic acid solution.

The student uses 7.0 g of sodium hydrogencarbonate to neutralise the ethanoic acid solution.

The heat energy change, *Q*, is 3200 J.

Calculate the molar enthalpy change, ΔH, in kJ / mol.

Include a sign with your answer.

[for sodium hydrogencarbonate, $M_r = 84$]

(4)

$\Delta H = \frac{n}{Q} = \frac{n}{3200}$

$n = \frac{m}{mr} = \frac{7}{84} = \frac{1}{12}$

$\Delta H = \frac{1}{12} / 3200$

$\pm +2.6 \times 10^{-5}$

$\Delta H =$ + 2.6 x10^{-5} kJ / mol

ResultsPlus
Examiner Comments

This candidate gained the first marking point for finding the moles. They used a fraction rather than a decimal, but this was acceptable in the first stage of the answer. Unfortunately, they failed to convert J to kJ and they divided moles by Q, which was the wrong way round. They did, however, score the fourth marking point as their answer was correct and was given the positive sign. This showed that the candidate understood that the reaction was endothermic and knew that the sign was positive.

ResultsPlus
Examiner Tip

As working was shown clearly, an error carried forward mark was awarded, so showing your working is needed to gain extra marks.

Paper Summary

Based on their performance on this paper, candidates should:

- Learn descriptions of chemical tests.
- Always show your working when doing calculations as you are likely to pick up error carried forward marks.
- Read the questions carefully so as not to miss important points when answering the questions.
- Use any data that is provided in the questions.
- Watch videos of practical demonstrations.
- Learn definitions that are in the specification.

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