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Oxford Cambridge and RSA

GCSE

Chemistry A

Twenty First Century Science Suite

General Certificate of Secondary Education **J244**

OCR Report to Centres June 2014

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This report on the examination provides information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

Reports should be read in conjunction with the published question papers and mark schemes for the examination.

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OCR REPORT TO CENTRES

A171/01 Chemistry A Modules C1, C2, C3 (Foundation Tier)

General comments:

As with the previous series, Candidates were well prepared to answer the longer 'level of response' style questions. It was pleasing to see that the number of questions left blank was smaller than in previous series and the performance of the candidates was generally improved across the paper. There remains a number of misconceptions and also difficulties in candidates not addressing the question that was posed.

Comments on Individual Questions:

Question No.

Q1a (i) Whilst almost all students attempted the question, there were few correct answers. The candidates may not have completely read the question before choosing their answer as the common incorrect response was 'oxygen'. This would be a reagent rather than the other product of the reaction.

Q1a (ii) This was generally well answered with candidates most able to identify carbon dioxide

Q1b Many candidates struggled to follow the instructions set out by the question. Some failed to make a decision as to who was correct, Dom or Kate. Where a level 2 response was given it commonly included the link between the number of cars and the pollution given out by them in comparison to a bus. The link between volume of fuel burned and pollution given out or number of cars was less common. This limited the level achieved. Once candidates chose Dom the majority gave an argument for air pollution, or a fuel, rather than both. Many candidates expressed the idea that there would be more people on each bus which would reduce number of cars and then linked fewer cars to less pollution. Weaker candidates just repeated the information given in the question. Very few candidates omitted the question.

Q2a Candidates could identify sulfur and oxygen as the elements present in sulfur dioxide, however an alarming number told us that carbon dioxide was an element present in sulfur dioxide. Fewer candidates could identify the source of the elements.

Q2b – Almost all candidates could describe the general shape of the graph. Most candidates could also describe the three individual sections of the graph.

Q2ci – Around half of the candidates could identify the statement was describing 'a correlation'.

Q2cii – This question asked the candidates to 'describe and explain another way' to reduce sulfur dioxide put into the air from power stations. Unfortunately candidates generally talked in terms of adding catalytic converters to cars rather than actually answering the question that had been asked.

Q3a – Generally well answered with most candidates identifying carbon dioxide as the correct response.

Q3b – Many candidates scored both marks here. There were surprisingly few answers that referred to the role of plants. Commonly scored points were reduction in carbon dioxide and increase in oxygen, but misconceptions included the processes of respiration to provide oxygen or plants breathing.

Q4ai – It was pleasing to see that most candidates could correctly calculate the mean. Where Candidates had made an arithmetic error but showed their working, one of the two marks were awarded, most commonly the correct addition and division of the numbers but perhaps '=' had not been pressed on the calculator. Some candidates incorrectly identified outliers and so lost marks

Q4aii – Almost all candidates could identify the range.

Q4aiii – Very few candidates scored this mark as they couldn't make the link between the lower end of the range of the new bags and the breaking point. Perhaps the significance of the data was not understood.

Q4bi and 4bii – Both were well answered.

Q5ai – Almost all candidates scored at least one mark, most scoring both marks. Where candidates did miss the second mark it was generally the idea that 'the amount of crude oil used to make chemicals is the same as the amount of lubricant' that was thought to be false. The barrel showing this information to be true was at the top of the page.

Q5aii – Very few candidates scored just 1 mark. Either 2 marks for correctly carrying out the two stage calculation or no marks. Common errors included incorrect addition and failure to subtract 45 from 100 to get the final answer of 55%

Q5b – Most candidates scored 1 mark for correctly identifying the fact that 'gas molecules are smaller than molecules of fuel oil'. The other two parts to the question were generally poorly answered.

Q6a – Knowledge of nanoparticles varied greatly. Candidates struggled to get beyond level one answers (2 marks) as they didn't discuss the risks **and** benefits in socks **and** plasters. There were lots of misconceptions such as nanoparticles made plasters heal wounds quicker.

Q6b – A very open ended question which allowed candidates the opportunity to demonstrate their ideas. Unfortunately few candidates could say how the properties of the item were improved by the nanoparticles. The most common correct answers involved sports equipment as the properties were easy to describe.

Q7ai – Candidates found it difficult to identify both correct responses for the 1 mark.

Q7aii – Candidates performed much better on this question, where only one tick was needed for the mark.

Q7aiii – Most candidates identified Mrs Evans as the better way of assessing the amount of salt present in food. The idea that it was good that Mrs Evans checks the labels to monitor her salt intake was seen regularly. It was pleasing to see a large number of candidates show an understanding that food may contain hidden salt.

Q7aiv – Most candidates scored this mark for the idea that salt is used to improve the taste or flavour of food.

Q7bi – This question was an overlap with the higher tier. Many candidates incorrectly referred to the ease of extraction in solution mining compared to digging rocks. Where marks were scored it was for referring to the difference in purity or the difference in labour intensity of the two processes.

Q7bii – Candidates struggled to correctly identify potassium hydroxide as the correct answer. The most common incorrect answers was potassium oxide.

Q8 – The majority of candidates were level 2 or above in standard as they could identify the trend of the graph and provided the explanation that chlorine kills bacteria/microbes in the water. Where candidates didn't refer to the graph, they could provide advantages and disadvantages of adding chlorine to the water supply and so still achieved a level 2 mark. A common disadvantage given was that 'chlorine can cause cancer' rather than the idea that chlorine will react with organic compounds in the water to produce carcinogens. Credit was not given for this without the idea of a reaction firstly taking place. Where candidates were limited to level 1, it was usually because they didn't supply a disadvantage for adding chlorine or discuss the graph.

Q9a – The majority of candidates couldn't identify chlorine as the correct response.

Q9b – Most candidates scored 1 mark here, identifying that 'there is an environmental impact when each product is made from PVC'.

Q9ci – Many candidates did not read the values correctly from the graph. The total of PVC recycled was often incorrectly quoted as 250,000 or 300,000 rather than the correct response of 260,000 for 2010. The difference between the values in 2010 and 2000 was rarely quoted as 210,000.

Q9cii – Many candidates identified that the waste would go to landfill if it was not recycled. Fewer candidates could give 'saving resources/energy' as a good reason or advantage for recycling.

A171/02 Chemistry A Modules C1, C2, C3 (Higher Tier)

General Comments:

This paper was well answered by the majority of candidates. The questions differentiated effectively and there was a wide range of total marks on the paper. Almost all questions had responses and there was no evidence of candidates being short of time. There were a small minority of candidates entered for this paper who would have been better suited to the foundation paper.

There were some excellent answers to the 6 mark, free-response questions. Candidates have improved on their ability to construct relevant and informative answers to these questions. Objective questions were also well answered and candidates had a clear understanding of ideas about science.

Numerical questions are improving too. Almost all candidates were able to calculate a mean correctly and workings for calculations were shown. However, when asked to justify an answer to a question, candidates were reluctant to use calculated data even when it was asked for. Such evidence is needed to justify an answer More practice on this type of question should improve candidates' responses.

Candidates still find it difficult to apply their knowledge and understanding of science to different contexts. There is a tendency for candidates to write down pieces of scientific knowledge, without thinking whether they fit into the new context and answer the question.

Candidates should also be encouraged to take great care when they read the questions. Markers reported that candidates frequently gave the impression of not having read the questions properly.

Comments on Individual Questions:

Question No.

1ai This first question was well answered. Almost all candidates were able to take data from the graph, but some were unable to process this data. A common error in the calculation was to subtract instead of divide. Some candidates did not read the instruction and gave the answer as a decimal.

1aii Most candidates scored on this question. Some only gave one piece of evidence for their answer so limited their mark. Some, who did not read the question carefully, discussed the fall in sulfur dioxide per year or per 5 years. Candidates should be aware that if they write answers such as 'the graph clearly shows it falls to a third every ten years' no marks are awarded. They need to show how they came to this conclusion.

1b Many candidates were able to describe the correlation shown by the two graphs. Again, weaker candidates did not read the rubric correctly and just described the second graph. Candidates should be discouraged from using 'positive' and 'negative' when writing about correlations in science. Their use of these words was often wrong, although their descriptions of the correlation were correct. Descriptions are much more relevant in a scientific context.

1ci This was a discriminating question on the diagrammatic representation of a reaction. However, some good candidates lost marks because their careless drawings showed non-touching atoms within a molecule.

1cii This was a challenging question. There were too many vague comments about harmful and dangerous chemicals which did not score. Few candidates scored both marks as those who gave relevant comments concentrated on either hydrogen sulfide or sulfur, but did not discuss both.

2a This first of the six mark questions was a common question with the foundation tier. Most were able to reach level 2 by comparing the pollution caused by buses and cars, but few linked pollution to the amount of fuel burned, which would have raised them to level 3.

2b Knowledge of biofuels was weak. Again, candidates gave vague comments about pollution which failed to score. Some candidates believed that biofuels do not emit polluting gases when they burn. Also there was a common misconception that biofuels do not release carbon dioxide when they burn.

2c Another discriminating question with most able candidates gaining both marks. Some weaker candidates were confused by the terms ‘complete’ and ‘incomplete combustion’ and linked these terms to the incorrect amount of oxygen or the incorrect products of combustion.

2d This was well known. Those who gave an incorrect answer often chose ‘carbonised.

3ai Almost all candidates could correctly calculate a mean.

3aii Candidates had much more difficulty using their calculated data to answer this question. Some wrote that the new bags were weaker with no attempt to use their data to justify this statement. Many others just quoted the change in the mean values for one mark. A few of the more able realised that there was only a small overlap in the ranges and fewer correctly pointed out that the mean of the new bags was outside the range of the old bags.

3b There were some good descriptions of crystallinity in HDPE and its effect on inter-molecular forces and the strength of the polymer. Some candidates are still unclear about the difference between inter-molecular forces and covalent bonds whilst others incorrectly answered this question in terms of cross linking and plasticizers.

4a This calculation discriminated well, though it had the highest number of ‘no responses’ on the paper. A common error was to include lubricants and give 139 as the fuel total. Some calculated correctly, but then incorrectly ‘rounded’ their answer.

b There were some excellent answers to this 6 mark question with logical explanations for the trend in boiling points. Unfortunately some candidates gave correct explanations without answering the question about the trend and therefore lost marks. Careful reading of questions should eliminate such errors. Weaker candidates confused intermolecular forces with covalent bonds again and a few were unclear about the difference between melting, boiling and burning.

5a Most were able to choose the correct size for a nano-particle. The most common wrong answer was 0 – 0.1 nm.

b Most candidates were able to score a mark here. Some failed to use a comparative when talking about expense and others thought that solid gold would reflect rather than absorb light.

c This was well answered with most gaining at least one mark. Some mis-read the question and wrote about the effect of nano-particles on the environment and there were some vague answers about nano-particles being harmful.

6a This was an overlap question with the foundation tier and was well done by almost all candidates taking this paper. In part i most were able to identify both methods of peer review though some lost marks by only ticking one person. The other parts of this question were all well done by candidates on this paper.

6bi This was another question eliciting vague comments about environmental harm, which did not score. More able candidates knew that solution mining gave purer potassium chloride, but few found a second reason for this mining process. Many candidates confused with sodium chloride and wrongly suggested that rocks of potassium chloride could be put on the roads. Also, many thought that subsidence was the result of underground mining only, whereas subsidence may occur after either method has been used.

6bii Few scored on this question and some able candidates, who knew the products of electrolysis, lost marks by writing sodium hydroxide instead of potassium hydroxide.

7 Candidates found the first graph difficult to interpret. Some thought it showed the population rising and missed the link mark. Others thought that an increasing amount of chlorine had been added to the water. Disappointingly when they did interpret the graphs correctly they failed to describe either graph in detail and were limited to 2 marks. Very few evaluated the effectiveness. All these points indicate careless reading of the question. Some candidates discussed the disadvantages of chlorinating water. These are not relevant in situations where there is a high risk of death from water-borne disease.

8a This was well answered with almost all candidates scoring at least two marks.

b There were many correct answers to this objective style question with almost all gaining at least 1 mark.

c This part of the question proved more difficult. Few candidates were able to say that the direction of magnetism was measured. Many just repeated the question and said they measured the magnetic properties or just the magnetism of the rock, but they found it much easier to write correctly about what such measurement tell them.

A172/01 Chemistry A Modules C4, C5, C6 (Foundation Tier)

General Comments:

The paper produced a good spread of marks with no evidence that candidates struggled to complete it on time. Most candidates attempted all the questions.

Candidates have become more confident in tackling the six-mark extended-writing questions and most are trying to structure their answers. There are still many that do not address the question, just writing anything they know that might be relevant. This means that they do not tackle all the aspects required in the question and so limit the level they can achieve. In order to access the higher marks they need to include more details and scientific points in their responses.

The interpretation of data was also often done well although sometimes it was done in less detail than was expected.

Many candidates are still hampered by lack of knowledge of practical techniques and so are unable to apply this to experimental methods asked for. They also find it difficult to remember the observations in practicals that they have covered.

Most candidates proved to be confident with the substitution of appropriate values into a formula and its correct evaluation and with calculating a mean.

Comments on Individual Questions:

Question No. 1

In **1(a)**, most candidates correctly identified magnesium as the missing metal in the table and many could also write the correct formula for sodium chloride. Others did not use the periodic table provided and were unable to remember the symbol for sodium and so gave SoCl as their response.

There were some good responses in **1(b)** that showed a clear understanding of the pattern of the formulae of the chlorides shown in the table and illustrated this understanding by reference to the chlorides of both sulfur and phosphorus. Some candidates only referred to one of the elements and others gave reasons unrelated to the pattern shown by the formulae e.g. that the elements were metals rather than non-metals.

Many candidates correctly wrote the word equation in **1(c)** for the reaction between sodium and chlorine to produce sodium chloride. Others incorrectly wrote chloride instead of chlorine or included other substances, such as water.

Question No. 2

Many candidates correctly identified both the properties of the Group 1 metals in **2(a)(i)**. Others chose information about melting or boiling points instead.

Most successful responses in **2(a)(ii)**, described the production of bubbles/fizzing/hydrogen when Group 1 metals are put into water, with a few also referring to the vigour or speed of the reaction. Some responses gave descriptions only relevant to potassium e.g. bursting into flames and others were too vague e.g. just dissolving of the metal.

In **2(b)**, most candidates were able to correctly link the group of non-metals with the property that they are present in molecules in the air and many were also able to make the other 2 links successfully.

There were some good responses where candidates were able to apply their understanding of the processes of peer review to the example given in **2(c)(i)**. The idea of checking the results was the most common correct response although some realised that they should see if it applied to other triads.

In **2(c)(ii)**, most candidates understood that they needed to calculate a mean value and compare it with the relative atomic mass of silver and there were some clearly explained responses. Many responses showed that candidates had not read the stem of the question carefully as they calculated the mean of all 3 numbers given.

Question No. 3

There were some excellent responses to this level of response question where the candidates clearly linked the radius of the atoms with the number of electron shells and then went on to make predictions for the other two elements. These candidates often showed planning by highlighting the key ideas in the stem of the question, to ensure that they covered all the required points. Many responses looked at the data and described trends in the number of electrons and the atomic radius without relating them to the question asked, which was about electron shells. Others only partially answered the question by either not including any predictions or by only making predictions.

Question No. 4

In the four parts of **4(a)**, most candidates were able to select the appropriate chemicals by interpreting the given data. In **4(a)(ii),** some struggled to correctly identify a gas using the boiling point data and chemical D was a common error.

Responses to **4(b)** showed that candidates had a good understanding of the link between uses of metals and their properties.

Question No. 5

Good responses to this level of response question used information from both the graph about demand and the table about supply, to explain that there is a concern that supply will no longer meet demand for copper in the future. The best candidates being able to process the data by showing that demand is expected to double or is now increasing more rapidly than before. A few responses were also able to process the information about supply by discussing the problems with there only being a few countries currently supplying copper. Many responses gave good descriptions of the data, especially the graph about demand, but did not explain why they show a reason to be concerned. Some candidates tried to explain concerns about the availability of copper in the future without referring to the information given.

Question No. 6

In **6(a)**, most candidates successfully chose the small amount of copper in copper ore as the reason for the production of large amounts of waste rock. Many others chose the comment about why the rock is considered to be waste.

Most candidates were able to use the data sheet to select appropriate the observations or tests for ions required for **6(b)**. Some responses did not give full responses e.g. did not include that the blue precipitate would not dissolve in excess sodium hydroxide and others did not use the data sheet at all.

In **6(c)(i)**, many candidates were able to recall the name of the process which extracts metals using an electric current. There was a wide range of unsuccessful guesses. In **6(c)(ii)**, most candidates understood that it was the ions that were responsible for the electrical conductivity of copper sulphate. The conductivity of solid copper was the most frequently chosen incorrect response.

Question No. 7

There were some very good descriptions of the method to produce crystals for **7(a)**, with candidates choosing the correct sequence for the various steps of the process. Many did not realise that excess zinc carbonate should be added and so consequently either missed out the filtration or used it later in the process to separate out the crystals. Others did not understand that the solution needed to be heated to allow the solution to become more concentrated by evaporation, thinking that the heating was to speed up the reaction between the carbonate and the acid. A few did not relate the given diagrams to the required method and just described what was happening in each diagram in the order given.

In **7(b)(i),** many candidates successfully subtracted the mass of the weighing bottle to calculate the mass of product formed. Others did not do a calculation and just chose one of the masses from the table. Candidates were more successful in substituting appropriate values into the formula given in **7(b)(ii)** and were able to correctly calculate the percentage based on the value they had given in part b(i).

In 7(c), some candidates recalled the gases produced when an acid reacts with a carbonate and with a metal. Others struggled to recall these and sulfur dioxide was commonly linked with the reaction between sulfuric acid and a metal.

Question No. 8

Candidates showed a good understanding of the graph in **8(a)** and could correctly identify what was happening at each point on the graph. A few confused speeding up with slowing down and others inappropriately drew multiple lines.

In **8(b)**, some candidates successfully chose zinc chloride as the product of the reaction between zinc and hydrochloric acid. Common incorrect choices included zinc hydroxide and various sodium salts.

In **8(c)**, most candidates were able to suggest an appropriate investigation, usually either the addition of copper or the expectation that a faster reaction would occur. Many chose to use the catalyst instead of the zinc and others omitted to say what the expected result would be.

In **8(d)**, most candidates understood that the arrow showed the energy change of reaction with many also correctly selecting reactants for the start of the reaction. Many others chose catalyst or rate of reaction for the start of the reaction.

A172/02 Chemistry A Modules C4, C5, C6 (Higher Tier)

General Comments:

Candidates used their time well and were generally very well prepared for the examination. Some individual candidates left questions unanswered but in general candidates attempted all questions.

Candidates had learned the specification content and showed comprehensive knowledge of the statements from the specification. Most able candidates were able to discuss detailed information about Group 1, electron arrangements in atoms, catalysis, rates and collision theory. In addition many candidates showed very high levels of skill in their handling of formulae and equations, which were tested in different ways throughout the paper.

In answering questions, candidates need to take care that they do not merely repeat the question in their answer. This resulted in lost marks in questions such as 1bi and 2a (see below).

For the six mark questions, it is important that candidates read the question carefully and make sure to answer all of the task. The most common reason for lower levels being scored was that the answer given did not address the whole task, for example in 2a it was relatively common for an answer to omit any mention of electron shells. In 5a some candidates did not clearly state why scientists are concerned about the balance between supply and demand of copper. For question 6a, many candidates did not discuss rate of reaction at all.

Comments on Individual Questions:

Question No.

1a Just over half of the candidates gained at least one mark for identifying the products of the reaction between Group 1 elements and water. Those who did not often discussed other aspects of the reaction, for example ‘fizzes and bubbles’ without directly identifying a product.

1b Almost all candidates identified trial D as not fitting a modern group. Fewer gave an explanation. ‘They are in different groups’ was not considered enough to score.

1c i This was well answered. Almost all candidates could give some ideas about what scientists do to check ideas. Some discussed peer review, others discussed checking data and/or calculations. In this type of question, it is important that candidates are careful not to merely reword the question. Such answers cannot score, hence answers that were close to the question wording of ‘evaluate his data and ideas’ could not score.

1cii The commonest error was to take a mean of all three values rather than a mean of the top and bottom. Most candidates had understood the information in the question and were able to discuss how the mean did not match that of silver, even if they had miscalculated the mean of copper and gold.

2a Some candidates gave answers that were too close to a restatement of the question. For example stating ‘the number of electrons in the outer shell is linked to the formula of the metal ion’. This does not *describe* the links, which is what the question demands. A better answer would be ‘the positive charge on the ion is the same as the number of electrons in the outer shell’ or ‘as the number of electrons in the outer shell increases, so does the positive charge on the ion’.

2b This was well answered, showing that writing formulae is something that candidates are skilled at doing. Over 80% gained both marks.

2c The ions and their charges was less well answered with less than half the candidates scoring both marks. Common errors were to incorrectly represent the chloride ion as Cl^{3-} or Cl_3^-.

3 This question relied on the interpretation of data. Candidates processed the data well, showing that they are skilled at manipulating unfamiliar data.

About a quarter of candidates gained a level 1 or zero marks. This was usually because they did not engage fully with the question. To gain a level 2, the answer needed to discuss the data in the context of electron shells. Many candidates referred only to numbers of electrons (which were given in the table) rather than discussing electron shells (which is what the question asked about).

However, those who did discuss the arrangement of electrons in shells showed very good understanding of concepts such as the effect of increasing distance of outer electrons from the nucleus. Some very high level responses were seen. Well over a third of candidates gained a level 3.

Some candidates showed poor communication skills by confusing electrons with atoms in their answers.

4 ai Most candidates gained at least one mark, showing sound understanding of electrolysis. However, the marking scheme demanded that candidates correctly identify three of the five statements as being true or false to gain one of the available two marks. About a quarter of candidates did not do this and so failed to score.

4aii Candidates found this question very challenging. Although most stated that aluminium ions are attracted to the negative electrode, they could not express what happens to them there, other than that they 'lose their charge'. Some thought electrons were lost. However, about a third of candidates stated that aluminium gains three electrons and many of these gave a fully correct equation.

4bi Errors in the equation meant that almost half the candidates did not score. Some gave incorrect formulae, such as CuO_2 or Cu_2, others reacted the copper oxide with an oxide of carbon. In this case, the reactants and products are described in the question. Candidates are encouraged to make sure they read such questions carefully before beginning to answer.

4bii About half of the candidates could describe reduction. Some even expressed reduction in terms of electron gain.

4biii Candidates did not generally know that aluminium cannot be extracted by heating with carbon due to its reactivity. Some answers stated that 'carbon is not strong enough' or other vague ideas that did not link directly to the reactivity of the elements.

5a This question was shared with the foundation tier. A full spread of marks were seen on the higher tier paper, where the question discriminated well. The main barrier to scoring higher marks was that some candidates did not access all parts of the task fully. The question asked candidates to 'discuss why scientists are so concerned' in the context of the balance between supply and demand for copper. Some described data but did not clearly express why the data gives cause for concern. Others only discussed one aspect of the data; either demand or supply. Level 3 answers were expected to show some processing of the data, for example by calculating the total reserves of copper in the four main countries, or making an estimate of the years' supply left. About a third of the candidates gave answers at level 3.

5b Almost half of the candidates gained at least one mark for the correct labelling of the metallic structure, usually for identifying the electron correctly. A common error was to either label the copper ion as a proton or to label the electron as a negative ion.

5c Almost two thirds of candidates knew that copper particles slide over one another.

5d Most knew that precipitates have characteristic colours. A common error was to think that the metal ions neutralise the sodium hydroxide.

6a This level of response question again caused difficulties for candidates who did not fully answer all aspects of the question. Candidates were asked about the rate of reaction at A, B and C and to explain their answer in terms of ideas about collisions.

Firstly, many candidates did not mention rate, but rather discussed answers only in terms of mass change. Such answers were limited to level 1. A second common problem was that candidates discussed collisions between reactants rather than between particles or between named particles, for example saying 'the acid is colliding with the zinc'. Where collisions were discussed, they often were only mentioned in terms of *number* of collisions rather than in terms of *frequency* of collisions or of number *per unit time*. The most common mark for this question was four, with less than a quarter of candidates gaining a level 3.

Some candidates made errors which limited the marks. For example, some thought that initially the rate of reaction is steadily increasing. Others said that energy increases as particles collide. These answers were considered to have some communication impeded and scored the lower mark of each level.

6b Almost all correctly identified zinc chloride.

6c This question was well answered, with most stating that copper should be added to lead to a faster reaction. Some omitted to say that this should be compared with a reaction without copper. A common error was to change other conditions, for example heating the reaction.

6d This is an example of an objective question that demands all answers to be correctly chosen for a single mark. In most cases candidates made at least one error and so failed to score.

7 This question was not intended to be a very challenging question, but candidates did not score highly. This may be because it was late in the paper or because candidates did not use the provided data sheet from page 2 of the paper (even though this was referenced in the information for the question).

7a About half of the candidate gained some marks. Usually, this was for correctly selecting the ions in hydrochloric acid. Common incorrect selections for sulphuric acid included H_2 and S^{2-}.

7b Both parts of b were poorly answered. Candidates did not seem to know that the pH of all acids are similar or that they would both react with magnesium. Those who did select the correct tests in the correct places usually gained all three marks in part ii) for correctly describing the changes they would see. However, over 75% of candidates failed to score in both question parts.

7c Most candidates gained one mark, either for giving the correct name and formula for sodium chloride or for naming both salts correctly. The formula for sodium sulfate was less well known.

A173/01 Chemistry A Module C7 (Foundation Tier)

General Comments:

The performance of candidates overall in this paper was comparable to other series. Candidates were willing to attempt many of the questions, including the Level of Response 6 mark questions. Many candidates were conversant with scientific language, including scientific vocabulary in their extended responses, and identifying the correct words to use in different situations, such as “exothermic” as being a reaction that gives out energy.

Candidates demonstrated an awareness of sustainability and the importance of reducing waste in industrial reactions. Many were able to explain that processes were more “green” if waste was reduced. Despite this being a foundation paper, candidates’ knowledge of challenging ideas, such as the way catalysts work was extensive. In addition, many were able to use the idea of atom economy ion the correct contexts.

Candidates were less secure in their ideas about molecules; masses were frequently calculated incorrectly. Furthermore, candidates found the questions on chromatography challenging, with many accumulating only a few marks on Q.7.

Comments on Individual Questions:

Q.1(a) Generally answered well by the majority of candidates. Where mistakes were made, it was usually because extra products had been added into the equation.

Q.1(b)(i) Answered correctly by many candidates; the principle of conservation of mass had been taught well in centres, and candidates recognised how to arrive at the correct response of 44 tonnes.

Q.1(b)(ii) Many candidates achieved at least one mark here – usually for recognising that a lot of waste was produced by the reaction, and many were able to state that carbon dioxide is a greenhouse gas. Some candidates did not achieve full marks because they stated that the reaction makes carbon dioxide (already given in the stem).

Q.1(c) This question posed challenges for the majority of candidates. Two marks were rarely achieved. Despite the question stating that *both* processes produced carbon dioxide, candidates still used this as a response. This question required candidates to discuss both the intake and production of carbon dioxide; trees absorb carbon dioxide was sometimes given as a response, but candidates also needed to explain that this offsets the carbon dioxide produced in combustion.

Q.2 This question was answered extremely well by many candidates. Marks were achieved by almost all students attempting the question. Centres had taught the principles of the Haber Process in many instances, successfully, to a higher level. Responses given were well structured and clearly explained. Candidates had been careful to try and address all three aspects of the question. Their responses were detailed and included many key scientific terms. The term “catalyst” was explained well; often discussing the lowering of activation energy, or the provision of an alternative route for the reaction. The reasons for recycling of gases was often clearly depicted including reducing waste, and having a high atom economy. Furthermore, the details given about the process were exact; temperatures and pressures were stated, and it was common for candidates to have remembered that the catalyst was iron. The difference between four marks and six marks was usually because candidates had not mentioned a reduction in waste, or that some gases are re-used because they did not react in the first pass through the converter.

Q.3(a) Many candidates correctly identified the different chemicals in the production of the ester.

Q.3(b) Few candidates understood the term “equilibrium” in this context. Many selected Steve as being correct. This question required candidates to understand that there would not be 100% conversion, and that there would still be reactants and products present because the reaction is reversible.

Q.3(c) Candidates were often able to state carbon dioxide as a product of burning but rarely gave water as the second response.

Q.4(a) Candidates were aware of the uses of ethanol, with many achieving at least one mark. However, marks were needlessly lost because a use of ethanol was frequently stated as “alcohol” rather than “as an alcoholic *drink*.”

Q.4(b) Few candidates achieved any marks in this question. The required response was for recognition that yeast is used and this stops working at higher ethanol concentrations.

Q.4(c) Candidates lacked understanding of this process. Where marks were achieved, it was usually for simple operational points such as heating the solution and using a thermometer to monitor temperature. Some candidates were able to explain that there was evaporation and condensation. However, marks were sometimes lost because candidates were confused about which liquid was evaporated, when in fact *both* will evaporate, but the vapour is richer in ethanol. For six marks to be achieved, the question required candidates to describe the process simply, explain what happens to the liquids, and refer to the different boiling points of the liquids.

Q.4(d) This question was rarely answered well. Many candidates misunderstood the rubric and assumed that the table referred to the amount of poison produced from each alcohol upon heating.

To achieve full marks, the candidates were expected to realise that there is a difference between the amounts that can be consumed; to quote ethanol as the alcohol that will be produced at 79^{o}C, and to state that more of the ethanol can be consumed as its toxicity level is highest.

Q.4(e) Many candidates were able to calculate the correct number of atoms, and to select three as the number of elements in the formula. Where mistakes were made, it was usually on the total number of atoms; candidates had assumed that if there was not a subscript number next to the element then it need not be counted.

Q.5(a) Candidates were aware of neutralisation processes, and recognised this as a neutralisation reaction. However, many found it difficult to correctly sequence their ideas; indicator was frequently added at the end of the reaction and therefore the neutralisation would not work. In many instances, the alkali was described as being placed in a burette, rather than acid. The rubric clearly asked for consideration of a number of titrations, and few candidates discussed repetition of their experiments, or the reasons for repetition. Six marks could not be achieved without this as a factor in each candidate’s response. Although a correct sequence may have been described, without explaining that it was necessary to observe the volume of acid added. The best responses, were those where it was evident that the candidate had experienced the practical assignment themselves; clearly sequenced descriptions were explained; indicator was used (and a colour change made explicit); the volume of acid was noted, and finally, the experiment was described as having a “rough” titration initially, followed by several more attempts. In some cases, there was a description of the calculation of a mean.

Q.5(b) There were a number of very good responses here which included an explanation of James excluding an outlier, and how he calculated the mean. Incorrect responses were common; candidates described the value as the “median” value without considering the nature of the first result in the table.

Q.5(c) for full marks in this question, candidates needed to consider both parts to the question (the second was either ignored, or it wasn't clear from the response as to which part of the question was being discussed.) The best responses were those where candidates had explained the importance of checking for purity *over time*, and had then clearly explained that it was important that titration of collected samples should be immediate so that the sample didn't deteriorate. Many candidates appreciated that the samples may need checking due to safety and to protect consumers.

Q.6(a) The majority of candidates were able to select the correct definition for a reaction that gave off energy.

Q.6(b) There was a great deal of confusion in the answering of this question. Selected responses often seemed random; one mark was often achieved, but three marks were seldom achieved. The most commonly selected correct response was the energy needed to start the reaction being the activation energy.

Q.6(c)(i) Many candidates were able to correctly identify the number of molecules in a reaction.

Q.6(c)(ii) Candidates demonstrated a lack of understanding of the calculation of masses of numbers of molecules.

Q.7(a)(i) and (ii) Almost all candidates were able to interpret the diagram and understood that there were three colours in the original sample, but they were less secure about the most soluble colour. Good responses came from candidates who had experienced the experiment and they clearly explained that the most soluble sample moved highest up the paper. The most common misconception was for candidates to think that C was the most soluble because it was darkest, or that B was most soluble because it was lightest.

Q.7(a)(iii) There were a number of candidates who successfully achieved full marks in this question. However, frequently candidates had used randomly selected numbers to try and calculate the Rf value (values that were not given in the diagram). In some cases, the candidates had correctly used the correct numbers, but had incorrectly substituted them into the formula given in the rubric.

Q.7(b)(i) The best responses to this question were those where the candidates had used scientific vocabulary such as "insoluble", "solvent" and "solute." It was a common misconception that Alex didn't use enough pen, or that the spots had moved, just not much even though the diagram does not support this.

Q.7(b)(ii) Misconceptions meant that few candidates were able to explain that a different solvent was required. Candidates had completed experiments on chromatography, but many described that spots would have been observed had the paper been sprayed with a special dye, and therefore not appreciating that pen wouldn't be very useful if it was invisible.

A173/02 Chemistry A module C7 (Higher Tier)

General comments

Most candidates were entered appropriately for this tier and had enough time to answer all the questions. However, the candidates who scored zero, one or two marks on the whole paper would clearly have been better placed if they had sat the foundation tier..

Examiners noted that more candidates are prepared to show their working when answering numerical questions. As a consequence, this year several more candidates who gave incorrect answers were able to gain partial credit through the working shown

Examiners commented that, for extended-writing questions, those candidates who had had some practice in organising their thoughts into a coherent sequence tended to contradict themselves much less frequently, and to score more highly. Candidates are reminded that written communication is not limited to continuous writing. Answers which used bullet points or annotated diagrams often resulted in clear communication of all the salient points, and so were able to gain the maximum mark.

Comments on Individual Questions

1ai The calculation of atom economy was well attempted. A very common mistake was to mis-read 'the mass of all reactants as 'the mass of one of each reactant plus each product'. It was very pleasing to see that although a large minority of candidates may have got the wrong answer, they showed enough working to still gain some credit.

1aii Most candidates realised that a low value for atom economy meant a large amount of waste. There was some confusion between atom economy and percentage yield.

1b Most could suggest that trees are a renewable resource, and many realised that methane is a finite resource.

2a Most candidates were aware that an equilibrium would be achieved in the flask, and went on to discuss how the forward reaction was favoured in the Haber process. The role of temperature was not quite as well understood, and there were some muddled statements as candidates tried to sort out their ideas.

Beside the confusion over the role of temperature, the three most common misunderstandings were:
- that pressure is increased in order to speed up the reaction
- at equilibrium the *amount* of reactants equals the *amount* of products
- that the Haber process uses an enzyme catalyst. This was usually preceded by the use of the term 'optimum conditions', so presumably that term is too strongly linked to enzymes in the minds of some candidates.

2b This question explored candidates' ability to relate concepts of risk and benefit [IaS 6.1] to an actual example. Most candidates realised that the use of ammonia for fertilisers made a justifiable reason for its continued production and some discussed the concept of benefit versus risk. Some candidates found it very difficult to make a considered value judgement, and responses such as "ammonia isn't only used for explosives, it is a valuable resource used to make hair dye" did not gain credit.

3a Whilst any suitable formula for ethanol was acceptable, almost all candidates realised the significance of the OH group. C_2H_6 and C_2H_6OH were the most common wrong answers, and some candidates gave a word equation instead of a formula.

3b Candidates gave good explanations of alcohol distillation and discussed the difference in boiling point between alcohol and water. However, there was often confusion between the use of a condenser in this context and its use for refluxing. Other candidates recalled their notes indiscriminately and described fractionating columns. Weaker candidates had great difficulty in describing what happens in a condenser.

3c The table of lethal amounts for different alcohols was designed to apply information in an unfamiliar context, and proved difficult for candidates. Some candidates did not realise that the amount need to poison a person is inversely related to the relative safety of the alcohol, so suggested that ethanol was the least safe to drink of the alcohols in the table.

3d The balancing of the butanol equation was very well attempted, the weakest candidates gaining credit for writing the correct chemical species, the more able going on to balance the equation itself. Many candidates were able to put the correct numbers into the right hand side of the equation, the left hand side was, unsurprisingly, more difficult. Candidates who doubled the quantities for the equation were not penalised.

3ei Most candidates knew that hydrogen is the gas produced when sodium reacts with both water or butanol. A huge number of weaker candidates suggested that the gas was sodium hydroxide.

3eii The number of candidates who suggested that sodium sinks in butanol clearly shows that they were remembering the experience of seeing something in class.

4a Candidates found it slightly easier to choose the correct reactants than products for the esterification reaction. Some candidates did not read the question and drew more than one line.

4b This question proved to be surprisingly difficult for candidates to answer. It revisited the nature of reversible reactions and equilibria, but required candidates to think for themselves rather than depend on recall. Candidates often copied out material from the two statements in the question rather than apply their knowledge to the situation they were faced with. The command word ‘explain’ needs the candidate to use scientific ideas to say why the person is right or wrong.

4c Most candidates appreciated that the sulfuric acid is used as a catalyst and that it speeds up the reaction or lowers the activation energy. Weaker candidates tended to think that it increased the yield.

5a Most candidates were clearly familiar with the procedure for carrying out a titration, but there was also a significant minority who appeared to have little or no practical experience. There was a surprising number of descriptions of a burette as a “titration stick” or “titration tube”

5b Able candidates had no difficulty calculating the mass of sodium hydroxide in the solution, though others found it more taxing. Few candidates showed their working, so were not even able to gain that mark. This part was not attempted by a minority of candidates.

5c Most candidates realised that the first result was an outlier and that the best value was the mean of the other three results. Some candidates showed confusion between mean and median. Also common was “after discarding the first reading, 25.4 is in the middle of the other three”.

5d While calculating the relative formula mass was within the reach of most candidates, using the equation to decide what mass of acid reacts with 40g of sodium hydroxide was a lot more difficult and was not attempted by a significant minority.

6a Most candidates realised that the reaction is exothermic and that energy is given out to the surroundings. Contradictions were often seen, and there was the usual confusion over whether energy is released or taken in to make bonds.

6b Candidates were much more confident in describing the need for energy to break bonds in part 6b.

6c The number of bonds to be broken in the reaction was well understood, as was the calculation of the overall energy change. Many candidates even included the negative sign.

6d Most candidates understood that water was produced in both reactions, and usually also knew that carbon dioxide was produced only when hydrocarbons burn.

A174 Chemistry A Controlled Assessment

Overview

This was the second session for the assessment of the 21C Science suites Investigation controlled assessment. It was a real pleasure to see how most centres had responded to advice and guidance from last year. There were far fewer centres requiring scaling than last year and in general these changes were smaller. However a significant proportion of centres still had their marks altered this session, with large scalings. The most common cause of significant changes to centres marks still relates to the hierarchical nature of the marking criteria, details of which are addressed below.

A serious cause for concern was the increase in malpractice cases. These nearly always involved centres who are giving too much guidance or feedback. They are giving too much guidance because all candidates are following same methods, same limitations and improvements, same references, etc.

Candidates' scripts from a small number of Centres were overly long, although timings indicated in the specification are for guidance only; it was clear that in some instances these had been exceeded markedly to the extent that in some instances this was malpractice. Candidates should not be allowed unreasonable amounts of time and it should be impressed upon candidates that producing reports is an exercise in conciseness.

Administration

A significant number of centres entered candidates for the wrong component, significantly delaying the requesting of manuscripts. Please note that the suffix /01 is for entry via the repository (i.e. electronic copies of candidates work) and the suffix /02 is for the normal postal moderation.

Documentary evidence of internal standardisation was also supplied in a large number of instances, but for many Centres, this was not provided. Cases of insignificant inconsistent marking seen suggested that internal standardisation procedures had not been applied by some Centres, and Centres are reminded of their obligations:

'It is important that all internal assessors of this Controlled Assessment work to common standards. Centres must ensure that the internal standardisation of marks across assessors and teaching groups takes place using an appropriate procedure.' Section 5 of the specifications suggests some ways in which this can be carried out.

In general the provision of samples was very good, with work sent promptly with all the correct administrative documents. When not correct the most common omission was the CCS160 Centre Declaration although a number of centres failed to attach the Coursework cover sheet to the front of each candidate's work, which always causes problems for the moderator. When submitting samples please do not use plastic wallets; the preferred method for holding a candidates work together is treasury tags. There were few clerical errors this session, but where they did occur they were nearly always the result of careless addition or transcription of marks.

Few Centres provided their Moderator with detailed accounts of how the tasks and levels of control were administered; where present, these aided the moderation process.

Annotation

Annotation of candidates' work was excellent in many instances, but variable from Centre to Centre, and sometimes within a Centre. The annotation ranged from *just a series of ticks here and there* to *the relevant skill area code written adjacent to where the point had been made, backed up by a supporting comment.* We would always encourage centres to adopt the latter of the two approaches. Please note that it is a requirement that 'each piece of internally assessed work should show how the marks have been awarded in relation to the marking criteria'.

Hierarchy

A significant number of centres did not treat the criteria as hierarchical. Where this was the case centres were often significantly out of tolerance. Each statement at a lower must be met before marks can be awarded at a higher level. So for example all the criteria at level 1-2 marks need to be met before 3-4 marks can be awarded.

When marking the work each criteria should be annotated where it is met. Beginning with the lowest level and working up to the level where a criterion is not met. This will determine the level of marks awarded. If the candidate meets all the criteria a given level then the higher of the two marks is awarded. Where the candidate meets some of the criteria in a level the lower of the two marks must be awarded.

For example, in strand Eb a candidate who fails to make any comments about outliers is limited to a maximum of 3 marks no matter how well they consider the degree of scatter and general pattern of results. A consequence of this is that it is important that:

- candidates are taught to address lower level criteria as well as higher level criteria.
- teachers take care in identifying where the criteria are met otherwise quite large alterations in marks may result during moderation.

Particular criteria that have not been addressed by candidates are identified below

Interpretation of assessment criteria

Sa – formulating a hypothesis or prediction

For 21C Sciences a scientific hypothesis is a tentative explanation of science related observations or some phenomenon or event. The key point here is the idea of the explanation. A useful hypothesis allows a prediction to be made from it that can be tested experimentally.

The most common difficulties here were insufficient science used to develop the hypothesis. A common mistake was to provide 'a large chunk' of scientific knowledge but not relating this clearly to the development of the hypothesis.

Secondly, major factors were not considered <u>before</u> selecting a factor for the development of the hypothesis. It is not sufficient to state a factor, give a hypothesis and then list other factors as control variables. Candidates are recommended to structure their reports to make this process clear.

At the highest levels 7-8 marks it is important that candidates consider all relevant factors prior to selecting one. A quantitative predication must be derived or related to the hypothesis, not simply an unjustified guess.

It is worth mentioning that work in this strand may not be credited for work in strands Ra or Rb which are carried out under conditions of high control.

Sb - Design of techniques and choice of equipment

In this session, this strand was often generously marked. It was often not possible to justify the centre marks because students limited themselves to a maximum of 5 marks by failing to explain their chosen range of data. It was disappointing to find that the range (of the independent variable) was rarely explained. Centres seemed to believe that just ‘stating’ the range was sufficient. This explanation can be pragmatic, e.g. 'there were only 5 different strength lens available', based on safety issues, or 'the upper end of the range was limited to 2M as any more concentrated would be too corrosive', or based on prior knowledge/preliminary work 'from PE I know students cannot do step ups steadily for more than 3 minutes' or 'my preliminary work showed a reasonable change in the dependent variable of this range'. Note both ends of the range should be mentioned.

Good scientific justifications of the method, equipment and techniques selected must be provided for candidates to be awarded marks in the 7-8 mark level. Some candidates carried out preliminary work prior to the experiment proper. Although not a requirement, if it is practicable to do so in the allotted time, this can help to candidates to justify the method, equipment or range used. Justifications, however, were often weak, and the reasons for the use of a particular method, in particular, were often not provided. Many candidates produced tables, ostensibly to justify the equipment used, but these often listed every piece and simply described how they were used rather than justifying the choice; some very mundane statements were seen. At this 7-8 mark level, candidates should be using terminology such as ‘resolution’, ‘accuracy’ and ‘precision’ in their justifications.

In this strand, candidates are also required to review aspects of Health and Safety, ranging from comments, through to producing full and appropriate Risk Assessments. These were sometimes absent, and where a high mark had been awarded, Centre marks had to be lowered significantly. It is suggested that there is no excuse for omitting Risk Assessments; this phase of the task is under limited control, and more importantly, a Risk Assessment is a prerequisite to any practical work being carried out. Risk Assessment proformas can be used, and these should include the chemical, organism, piece of equipment or activity that is likely to constitute a hazard, the hazard defined (using the appropriate terminology), the associated risk(s), and measures intended to reduce risk. Risk Assessments should pertain to the experiment in question and not to generic hazards and risks (though clearly, candidates are not penalised for the inclusion of these).

Please also note the hierarchy of awarding marks here; hazards must be identified for 3-4 marks, with ’some precautions’ to minimise risk for 5-6 marks. While the word ‘some’ is used, it was not possible to support Centre marks where arguably the most important safety precautions are omitted e.g. the use of low voltage power supplies in electrical experiments. For 7-8 marks, for a Risk Assessment to be ‘full’, it must refer to *all* potential hazards and risks. This includes such things as using low voltage power supplies, limiting concentrations of solutions and the source of biological materials. Here, candidates should be encouraged to use statements such as ‘low hazard’ and ‘limited risk’. Candidates should also consider hazards and risks of a final product of the experiment, e.g. the products of a chemical reaction or incubated agar plate. For a Risk Assessment to be ‘appropriate’, the hazard/risk must be appropriate to that for the chemical/equipment/activity used or undertaken. At this level they should ideally refer to PAT testing of electrical equipment, COSSH, Cleapps Hazard cards or other similar documents and show an awareness of who/where the first aider is in case of injury.

C - Range and quality of primary data

Errors in marking in this strand tended to be at the higher end. The '*correctly recording of data'* at the 5-6 mark level requires meaningful column headings, correct units and consistency in the number of significant figures/decimal places used. To match 6 marks, candidates need to show consistency both with the number of decimal places reported for their raw data and the actual measuring instrument as well as including all quantities and units in table headings.

In strand C there is no need to do more than 2 sets of results if there is close agreement between the two sets obtained. If they are not close, however, then there is a need to do a further repeat for this value –an intelligent repeat. The *regular repeats or checks for repeatability* criterion would then be matched and a possible outlier could be identified. In the new (2011/2012) specifications for Twenty First Century Science, statement 1.6 in the 'Ideas about Science' has clarified the definition and treatment of outliers (compared with the version in the legacy (2006) specifications) to state, *"If a measurement lies well outside the range within which the others in a set of repeats lie, or is off a graph line on which the others lie, this is a sign that it may be incorrect. If possible, it should be checked. If not, it should be used unless there is a specific reason to doubt its accuracy."* Potential outliers in data collected during a Controlled Assessment should be handled in accordance with this statement, with the expectation that at this stage the measurement will be repeated/checked.

Please note that experiments that 'pool' data from a class are not suitable for this controlled assessment. Strand C is based on the primary data collected by the candidate. Data collected by other candidates is secondary data. It is very likely that a student pooling data with other students in a class will be limited to the 1-2 mark level.

A - Revealing patterns in data

Overall, the quality of work in this strand was disappointing. Arguably, this should have been the strand of the Practical Data Analysis where candidates scored the highest marks, but it was here where often the largest discrepancies between Centre and Moderator marks occurred.

Some graphs seen were of poor quality. There was clear evidence that some Centres had not checked the plotting of points carefully before awarding marks. Graphs drawn without appropriate scales, e.g. where these were non-linear, or without one or more labelled axes, and poorly-drawn lines of best fit, were often, incorrectly, awarded high marks. If the scale is inappropriate, or points are plotted incorrectly, the candidate mark cannot exceed four. Likewise, if an inappropriate line of best fit has been applied, a mark above five cannot be awarded, irrespective of whether the candidate has drawn range bars. For marks to be awarded in the highest mark levels, range bars must be drawn accurately (in addition to there being minimal errors in the plotting of data). The scales chosen by candidates often made difficult accurate plotting of data, as did crosses drawn with unsharpened pencils, particularly where millimetre graph paper was used. Although it is not essential that graph scales should start at (0,0), where axes begin with a 'zig-zag' section it is important that candidates do not extend their line of best fit into this 'undefined' area. This bad practice was seen on a number of occasions.

Please note that if computer generated graphs are produced they will be marked in exactly the same way as hand drawn graphs. In particular the grid lines on the graph must allow the plotting to be checked to 2 significant figures.

In some instances, however, candidates that were awarded very low marks having drawn very poor graphs could be awarded three or four marks owing to their calculations of means, a point sometimes overlooked by Centres.

Centres are reminded that for candidates to be awarded marks at the 5-6 mark level and higher, graphs having gridlines should be produced. They should not be drawn on lined paper. Where computer software is used to generate graphs, these should have appropriate scales, appropriate labelling, and gridlines. For candidates to score high marks, lines of best fit and range bars should be drawn manually.

Ea - Evaluation of apparatus and procedures

This was generally well assessed by centres however the common errors consisted of over marking candidates who suggested improvements but did not consider the limitations, hence not meeting the criteria at 3-4 marks.

Some improvements mentioned were trivial or lacked the detail required for higher marks. In general doing more repeats is unlikely to be a significant improvement.

There was some confusion over improvements to the experimental procedure and apparatus which is addressed here in Ea and the additional data or methods which can be used to increase confidence in the hypothesis which falls in stand **Rb**

Eb - Evaluation of primary data

A major stumbling point here was the requirement for outliers to be considered at level 3-4 marks. A significant number of centres ignored this requirement. In addition there appeared to be some confusion over what an outlier is, both amongst candidates and teachers. The criteria state *'individual results which are beyond the range of experimental error (are outliers)'*. Not all anomalous results are outliers, in particular averages are not outliers and a set of data points for a single value cannot all be outliers. In the new (2011/2012) specifications for Twenty First Century Science, statement 1.6 in the 'Ideas about Science' has clarified the definition and treatment of outliers (compared with the version in the legacy (2006) specifications) to state, *"If a measurement lies well outside the range within which the others in a set of repeats lie, or is off a graph line on which the others lie, this is a sign that it may be incorrect. If possible, it should be checked. If not, it should be used unless there is a specific reason to doubt its accuracy."* Potential outliers in data collected during a Controlled Assessment should be handled in accordance with this statement. Candidates are permitted to draw a graph of their results during the (limited control) data collection stage of the Controlled Assessment task. This may help them to identify potential outliers. Ideally, any data points that look to be potential outliers should be re-measured, and this is easiest to achieve if they are identified during the data collection session ie. strand C.

For 5-6 marks, although there were some often good discussions of spread of data, ‘repeatability’ was not always discussed. Candidates should discuss the spread of data qualitatively at this level, and quantitatively to obtain the highest marks at the top mark level at 7-8marks. Candidates’ evaluations were often very long, but many covered the pertinent points in the first few sentences.

Ra - Collection and use of secondary data
This strand was poorly addressed by many candidates.

The intention in Strand Ra is that candidates should do some research and find their own examples of secondary data. The OCR data in the 'Information for candidates (2)' document is only provided as a back up for those who fail to find any relevant secondary data from their own research.

Generally candidates are limited to 5 marks in Strand Ra if all they use is the OCR data and/or results from another candidate or group. In order to access 6 or more marks in Strand Ra candidates must present a 'range of relevant secondary data', which means that some data from the candidate's own research must be included and the source(s) of the data must be fully referenced. Guidance on referencing can be found in the 'Guide to Controlled Assessment' handbook for Unit A154 / A164 / A174 / A184 (Practical Investigation). The direct download link is http://www.ocr.org.uk/Images/77479-guide-to-controlled-assessment.pdf

Secondary data can be of different types:

- the data provided by OCR in the 'Information for candidates (2)' document;
- data collected by other candidates doing the same (or a similar) investigation;
- data from other sources (e.g. textbooks or the internet).

Data do not necessarily have to be quantitative; they can be qualitative. Students do not necessarily have to find a table of numbers that looks exactly like the one they have generated from their own experiment; graphs, descriptions of trends, conclusions, mathematical relationships, relevant constants, models and simulations can all be presented as secondary data.

It is helpful to the moderator if candidates include copies of the secondary data that they discuss in their report. This could be cut and pasted into the report (so long as it is clearly identified as third-party material), or may be attached to the end of the report. The material included should be carefully selected and cropped to show only the relevant parts, rather than comprising swathes of irrelevant material indiscriminately printed out.

Rb - Reviewing confidence in the hypothesis

This strand was also over-generously marked by some Centres. Candidates should be encouraged to re-state their hypothesis at the beginning of the review section to provide focus for this strand. Candidates often discussed findings but did not refer the hypothesis at all, or say if their data supported it. All candidates should make at least a statement referring to whether the hypothesis has been supported (or not), and the extent to which the data support the hypothesis.

At the 3-4 mark level upwards, candidates should make reference to some science when explaining their results. This was rarely done. It is not sufficient to merely refer to science used in Sa, as Sa is carried out under conditions of low control whereas Rb is done under high control conditions. At level 5-6 the science must be used to support the conclusion about the hypothesis.

When giving an account of extra data to be collected this must go beyond simply suggesting improvements to the procedure used, which is assessed in Ea. Different techniques or experiments that will provide additional data to assess the hypothesis are required for this strand.

Sources of Support

OCR offers several avenues of **free** support, including:

- The Principal Moderator's Report can be found on the OCR website.
- A 'Guide to Controlled Assessment' handbook for Unit A154 / A164 / A174 / A184 (Practical Investigation). The direct download link is http://www.ocr.org.uk/Images/77479-guide-to-controlled-assessment.pdf
- INSET training events for 2013-14 are available details may be found on the OCR website at http://www.cpdhub.ocr.org.uk
- We offer a Controlled Assessment Consultancy service, in which candidate work that you have marked will be reviewed by a senior moderator prior to moderation.

To make use of this service, post photocopies of three marked pieces of work to the following address: *Carolyn Brawn, Science Team, OCR, 1 Hills Road, Cambridge, CB1 2EU*.
Typically, we encourage Centres to send work which covers a range of attainment or which illustrates particular points of concern. The Controlled Assessment scripts should be marked and annotated before being photocopied. Please include a covering note on Centre-headed paper, and give a contact email address. A senior moderator will look at the work and will write a report on the Centre marking, which we will email or post back to you within 6 weeks. You can then make adjustments to your marking, if you wish, before submitting marks for moderation in May.

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

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Telephone: 01223 553998
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Head office
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Facsimile: 01223 552553