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Oxford Cambridge and RSA

GCSE

Additional Science A

Twenty First Century Science Suite

General Certificate of Secondary Education **J242**

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

A162/01 Biology A Modules B4, B5, B6 (Foundation Tier)

General Comments:

Many candidates showed that they had been well prepared for this paper. Instructions on how many boxes to tick in parts of some questions were well followed. Some calculated responses could have been improved by showing working out as well as the final answer e.g. in Q4.

The longer written answers were all generally attempted, especially Q2 and Q8. Where these responses could be improved it was almost invariably by recalling more scientific detail, e.g. giving a full description of the chemical changes in photosynthesis in Q2, or about chromosomes in mitosis and meiosis in Q5, or about reflex arcs in Q8. The best responses to these questions showed a clearly planned structure.

The description and interpretation of graphs involved in Q1(d) and Q3(d) were challenging. The best responses showed awareness of how to describe a range and of how to apply the key idea of correlation. Responses where the comprehension of what a correlation means was confused were difficult to award many marks to.

Candidates who correctly used technical terms such as mitosis, meiosis, zygote, and phototropism were better able to construct accurate and succinct responses to the questions.

Comments on Individual Questions:

Question No.

Q1 (a) was often well answered with a succinct phrase.

Q1 (b) called for three ticks, which most candidates did offer. It was most common for marks to be scored for “active site” and “enzymes are proteins”. Only the most successful candidates were able to link this to “made from instructions in genes”.
Q1(c)(i) was best answered by those candidates who used technical vocabulary e.g. “digests”. Some responses which did not score were couched in vague terms which often restated the question.
Q1(c)(ii) showed that those who did score a mark most often did so for the idea of the enzyme denaturing at high temperature. It was much less common for candidates to score the optimum temperature marking point, and many were explicit in giving 37°C or body temperature as the optimum, showing that their thinking was limited to the context of the human body.
Q1(d) was often well answered in terms of giving pH6 as the optimum, and some were able to score a further mark for describing the range. Few went on to explain that the enzyme does not work below pH3 or above pH9 clearly enough for a mark to be awarded.

Q2 was well answered by those who coupled a clear description of photosynthesis with features of the plant which could account for the rapid growth. The very best candidates used an equation to summarise photosynthesis. Far from all responses showed a clear or complete description of photosynthesis, and this greatly limited the marks they could score.

Q3(a) was correctly answered by many candidates who could correctly spell both aerobic and anaerobic. The substantial minority who did not score the mark seemed not to be aware of the terms at all rather than simply making spelling errors.

Q3(b) was well answered by many candidates. A number of others were able to score 1 mark by showing some working.
Q3(c) required candidates to realise that lactic acid would be produced by anaerobic respiration, and a number scored this marking point by linking this to pain or cramp. Candidates also needed to realise that Type A (aerobic) respiration provides a lot more energy than anaerobic respiration.
Q3(d)(i) was a challenging question which required candidates to understand the difference between positive and negative correlation. Some responses were limited by giving only a trend, e.g. in section A the heart rate goes up. The best responses were ones where the consideration of the graph was organised into the four sections on the graph.
Q3(d)(ii) was very well answered by the majority of candidates.

Q4(a) required the response zygote; where this was not given the most common incorrect response by far was embryo.
Q4(b) was a challenging question which required candidates to double the number of bacteria each generation. Many responses were 6 or 8 rather than the correct 7, but credit for doubling could only be given where there was evidence of working out on the paper.
Q4(c) needed recall of the fact of specialisation after the 8 cell stage, and the realisation that this represents three doublings. The question was very challenging, and the most common response seems to be 8.
Q4(d) was challenging in requiring the unprompted response of stem cells along with the idea that they would specialise at a later stage. It was most common to see descriptions of later specialisation scoring one of the marks.

Q5 was sometimes well answered by those who could name both mitosis and meiosis. Candidates also needed to be able to develop their answers with descriptions of what happens to the chromosomes in each of the processes.

Q6(a) was very well answered.
Q6(b) required the recall of the term phototropism as opposed to photosynthesis.
Q6(c) showed that it was challenging to link the idea that light energy is needed for photosynthesis to the idea that this would lead to the plant producing more food or glucose.

Q7(a) was very well answered.
Q7(b) was often well answered, with the great majority of candidates at least indicating option D.
Q7(c)(i) was fairly well answered. Where a mark was dropped it was by choosing one of the wrong options instead of realising that the patient needs to give informed permission for the research.
Q7(c)(ii) was very well answered, most candidates chose the correct pair of options.
Q7(d) often yielded one mark, though rarely both marks for realising that both the sensory and motor neurons would be affected.

Q8 required detail about how the response would arise within the squirrel to go beyond the most basic level of what the squirrel would do.

A162/02 Biology A Modules B4, B5, B6 (Higher Tier)

General

Few candidates left blank spaces, suggesting that there were no problems in finishing the paper within the time allowed.

Individual questions

Q1a This question asked for the direction of oxygen and carbon dioxide through the stoma of a plant which was photosynthesising. Most candidates answered correctly. If it was wrong, it was usually because the arrows were going in the wrong direction, or arrows were pointing in the same direction, or arrows were not labelled at all. Some candidates didn't put gases going into and out of stoma, but to the side or entering through the upper surface of the leaf.

Q1 b There was no specific pattern for incorrect answers here. Ticks next to "water vapour builds up inside the rolled leaf" seemed to be the most popular answer. There were 3 marks available here and this is usually a hint but not always to put three ticks. Candidates who put more that 3 ticks lost a mark even if they had 3 correct. Most common score was 2 marks.

Q2 Candidates were given a graph of rate of reaction of an enzyme against pH. They had to explain how enzymes worked and relate it to the graph. A considerable number just gave a general explanation of why pH affects rate, with excellent explanations, but with no reference to the graph they could only achieve level 1. Many candidates scraped into level 2 by discussing the graph and also mentioning denaturing of enzymes. Candidates who got level 3 - 5 marks often lost the final mark by not discussing both sides of the graph, or by making an error such as the incorrect pH number for the optimum (usually pH7). Many candidates discussed temperature, which was a pity as their explanations were excellent but scored no marks. Many thought the rate was increasing (to pH 6) because the particles were moving faster. Candidates obviously understood why increased temperature increases rate, but few understood why pH does. However, there were some excellent answers, including the idea of changed charges on atoms on the active site, denaturing, breaking of bonds and substrate unable to fit. This was then linked to both sides and the middle of the graph.

Q3 This question is about energy and respiration.
Q3a Candidates were given a formula to enable them to calculate a ratio. Many candidates gave fractions, so could score a maximum of 1 mark. Some managed to get to 19.2 in their working, but chose a different answer, e.g. 96/5, which suggests uncertainty about what was required, or what a ratio is.

Q3b Most candidates realised that Type A released more energy, with fewer scoring the lactic acid mark. Weaker answers focussed on the provision of oxygen as being necessary to survive/ complete the race and/or the need for water/hydration. Some candidates didn't answer the question and just discussed what aerobic / anaerobic respiration were and the fact that marathon runners need lots of oxygen.

Q3ci Candidates often lost marks because the sections (A, B, C and D) weren't specified. Some lost marks as they seemed to run out of steam, or maybe space, as they gave good answers for the first couple of sections then didn't do the others. They can obviously look at graphs and pick out patterns. They talked in terms of increase / decrease and not really in terms of positive/ negative correlation. Correlations were generally not well understood with many thinking that C showed no correlation and D a negative one. Candidates do not appear to understand negative

correlation, candidates think that going down is negative correlation ie in D they said negative correlation (instead of positive) as both decrease.

Q3cii – Generally candidates knew that confidence in a conclusion means repeating things on the same person. The most common wrong answer was the last box – repeating the same experiment with other runners.

Q4a This question required candidates to tick correct boxes concerning genes switched on in cells for photosynthesis to take place. Three marks were available and many candidates realised they should tick 3 boxes, generally scoring between 2-3 marks. Unfortunately, some only ticked 1, or more commonly, 2 boxes so couldn't gain the full 3 marks. Others ticked more than 3 boxes so lost a mark for each extra incorrect tick. There was no pattern to the wrong answers which suggests that candidates were unclear as to the function of a gene.

Q4b This required candidates to tick correct boxes concerning ethical issues surrounding the use of embryonic stem cells. 2 marks were available and this was well answered with many candidates gaining both marks. Unfortunately, some only ticked 1 and others ticked more than 2 boxes so, as above, lost a mark for each extra incorrect tick.

Q5 The question was well answered by a significant proportion of the candidates i.e. they were awarded 5 or 6 marks and there were remarkably few NR's. A few candidates gave excellent responses which were restricted to just coding or making points and were therefore limited to Level 1 but these were very much in the minority. Most responses that were awarded Level 1 marks were as a consequence of a lack of knowledge. Similarly a few candidates gave good answers with several coding or making points, but only a single point for the other aspect and were limited to level 2 because of this. One common 'error' seen was the occasional protein/enzyme being formed in the chloroplast. Not many but the very best candidates utilised the '3 bases needed to code for one amino acid' point although several did recognise that proteins/enzymes were made out of amino acids and that this involved a triplet code and some idea of a sequence or order. Some candidates completely misunderstood the question and gave details about how enzymes work (lock-and-key, etc.) but nothing creditworthy. Other common mistakes referred to the triplet code of amino acids or that at the ribosome the amino acids were made or that the bases are amino acids.

Q6a Many candidates were confused by this question. In this question the candidates were required to work out the difference between 2 auxin concentrations. It was very poorly answered and many candidates were unable to perform the calculation involving standard form. Many answers contained a string of 9s from some rather strange subtractions! They incorrectly interpreted 10^{-6} and ended up with answers 10 or 100 times less than they should. Another common error involved subtracting 10^{3} from 10^{6} or 10^{-6}. Some candidates did manage to gain 1 working mark and some did manage to perform the calculation correctly to gain full marks.

Q6b In this question candidates were asked to interpret a graph showing the effect of auxin concentration on the growth of shoots. They could gain 3 marks from 7 marking points; it was not well answered with many candidates scoring 0 or 1 mark. Six of the seven mark points required figures to back up a statement. In many responses either no figures were quoted or the figures were not within the acceptable ranges. E.g. the % stimulation increases up to 8ppm, the range of 6-10 was acceptable but many candidates were giving 5 or very commonly, 1-10ppm. Similarly, 70-90 was acceptable for 80 ppm where % stimulation equals 0 but many candidates were quoting 100ppm. Quite a few candidates mistakenly commented on root growth and others compared root and shoot growth.

Q6c Candidates were asked to explain how auxin caused phototropism in shoots. This question was well answered in general. Many candidates gained marks 'auxins go to the shady side, make cells here elongate and cause the shoot to grow towards the light.' Some did not gain the last mark because they described the shoot 'moving/facing/turning' towards the light which

was not acceptable. Only a tiny handful of candidates recognised that auxins were produced in the shoot tip and a few more mentioned diffusion. A few failed to gain credit because they talked about negative phototropism in roots but this was usually part of a weaker response and they often managed the 'shoot grows towards the light' mark. Some students failed to recognise the effect of the higher auxin level on one side and did not mention cell elongation or more/faster cell growth.

Q7a This question asked candidates to comment on two conclusions a student made regarding the results of an experiment where different areas of the brain were stimulated. Not many candidates were able to gain full marks for this question but the question was answered well by the stronger candidates, who were able to link 'flashing lights' and 'sounds' to a sensory response and movement to a motor response. Weaker candidates found this difficult to express, with some simply rephrasing parts of the question and some simply stating that they agreed. Some candidates related the conclusions to their own knowledge of the functions of parts of the brain but didn't comment on the results that the conclusions were based on. Others gave confused answers that tried to relate the conclusions to the reflex arc and not the results. Some candidates linked to motor and sensory neurons. Some students did reference the fact that there was not enough results / information to make accurate conclusions. Very few commented on the positions of the letters but those that did mostly linked this to the 'not enough information' marking point.

Q7b This question asked candidates to tick boxes about statements linking to SSRIs. The question was generally well answered with many scoring 2 or 3 marks. Nearly all picked up at least 1 mark for this with some ticking more than 4 boxes and losing a mark. Common mistakes were incorrectly ticking the 1st and 5th boxes, showing a misunderstanding of how SSRI's affect serotonin.

Q7c In this question candidates were asked to discuss ethical issues associated with using brain damaged patients for research. This was answered well in the main, with the majority of pupils either mentioning the idea of informed consent (some expressing this as the patient not being aware or understanding) and / or harming the patient further. Few candidates were able to express the idea that the patient may not benefit directly from the research. Some candidates clearly didn't understand the concept of 'ethical issues' with some mentioning problems with obtaining reliable results. Others simply stated that it was 'disrespectful' or that people would object due to 'religious reasons'.

Q8a This question asked candidates to identify conditioned reflexes. This question was very well answered with most candidates gaining the full 2 marks. A common mistake was ticking the top box (insect flies away when it sees sudden movement).

Q8b This question concerned Pavlov conditioned dogs and candidates had to link each action with its correct description. Many achieved full marks with a few getting 1 and not many achieving 0 on this joining boxes question. A common mistake was getting the primary and secondary stimulus the wrong way around.

Q8c Candidates were asked to give an example of a useful conditioned reflex. On the whole, this was not answered well. Some candidates answered with an example relating to birds associating the bright colours of a caterpillar with a bad taste / feeling ill and therefore avoiding them in order to prevent them from being poisoned. Other good answers included examples relating to training animals (e.g. dogs to sniff out drugs or to behave well). A lot of candidates gave examples of simple reflexes such as dropping a hot plate and others used an example given in 8d of not dropping a hot plate. Some obtained one mark by explaining the usefulness of the reflex (e.g. not damaging skin / not dropping food on the floor). Weaker candidates simply re-stated one of the examples already given in 8a.

Q8d Candidates were asked for an explanation as to how the brain can over-ride a reflex to drop a hot plate. This was answered poorly by most candidates. Some suggested that the brain could stop the pain receptors from detecting the pain, others simply stated that the brain 'chose to keep hold of the plate', others said that the brain could modify the reflex arc / stop the motor neuron from sending a message. A small number of candidates were able to state that the brain sent a message to the muscles in the hand to keep hold of the plate. Very few candidates were able to state that the brain sent an impulse to the effector. Signal and messages were the imprecise terms used by candidates. Candidates also answered along the lines that the impulses would arrive at the brain and be either re-routed, stopped altogether, or modified to make the impulse far less intense as a result, and so the effector would not respond. Others thought that through repetition you would gradually be able to get used to the pain and hence keep hold of the plate.

Q9 – In this question candidates were asked to suggest why a predator appearing causes a rapid response in a squirrel and to describe the processes that occur to allow the response to happen. Most pupils answered this very well, with many scoring 6/6 marks. Clear knowledge of the neuron pathways from receptor through to effector was demonstrated by many. Very strong answers included references to muscles as effectors as well as glands producing adrenaline. Few candidates referred to the properties of impulses (electrical, fast, short-lived) or to synapses. Weaker answers simply stated that the squirrel would 'run away' or 'see the predator and run'. Some responses referred to the 'eyes' or 'ears' of the squirrel and to the brain, but details of the pathway were either not given or were incorrect. Common mistakes included students referring to conditioning in the response and association of the predator with previous confrontations.

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 were 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.

A182/01 Physics A Modules P4, P5, P6 (Foundation Tier)

General Comments:

It was good to find that most candidates were able to answer each question on the paper, particularly the extended writing ones. It was noticeable that the majority of candidates earned higher marks on questions which required them to process information or data, but that they often fared significantly less well on questions that probed their recall of basic physics.

Comments on Individual Questions:

1 It was good to find that the vast majority of candidates were able to correctly identify the forces shown in the diagram of part (a). However, only a minority of candidates were able to earn full marks for part (b), with the majority incorrectly stating that the force acted on the object pointed to by the arrow, instead of the one it pointed from. Few candidates earned full marks for part (c), most drew two arrows in opposite directions, some drew them the same length and a few showed one coming from the ball and the other from the ground, suggesting that candidates have a very poor grasp of the conventions used to represent forces in diagrams.

2 Although the vast majority of candidates were able to calculate the correct value for the momentum of the ball in part (a), the need to square the speed when calculating the kinetic energy in part (b) defeated many of them. Too many candidates lost a mark by not explicitly comparing the kinetic energy of the ball with the energy needed to break the glass; simply stating that the ball did not have enough energy was not enough to earn the mark. The majority of candidates knew that increasing the speed of an object increased its kinetic energy for part (c), but only half knew that increasing mass also had the same effect.

3 This extended writing question required candidates to interpret a distance-time graph. It was good to find that the majority of candidates were able to earn full marks by correctly identifying the relative speed and direction of the subject. It was noticeable that a significant minority of candidates lost many marks by assuming a speed-time graph instead of a distance-time one.

4 This question also appeared on the Higher Tier paper, so was designed to be accessible to candidates operating at grade C. Not surprisingly, many Foundation Tier candidates struggled to earn half marks for it. Only a minority were able to sketch the graph with clearly labelled axes for part (a); many weak candidates assumed that the graph would be a straight line, thereby losing a mark. Part (b) required candidates to comment on a pair of statements stated by Edward; too many lost marks because it was not clear which statement they were referring to; simply saying that Edward was right/wrong earned no credit as his first statement was correct and the second one was not.

5 Most candidates struggled with this question about energy transfers in a demonstration using apparatus that the majority must have seen during their course. Despite the instruction to describe energy transfers, a concerning number of candidates managed to avoid mentioning energy completely in their answer, simply describing what happened in general terms when the weight was released. Many managed to name a type of energy in one part of the apparatus, but only a minority were able to state the type of energy going into a part as well as the type of energy coming out of it.

6 This question was about electricity, a topic that challenges most Foundation Tier candidates. It was therefore not surprising that only a small minority knew that potential difference was an alternative name for voltage in part (a). Although many candidates knew that the battery established the voltage across its circuit, only a minority knew the definition of voltage difference as work done on a charge moving through a circuit. Similarly, most candidates could draw a correct voltmeter symbol for part (b), many placed it incorrectly in series with the battery instead of in parallel; however, it was good to find that a substantial minority were able to earn full marks. Many candidates realised that inserting a second cell increased both voltage and current for part (c). Part (d) presented candidates with a circuit of three different resistors in series. Only a small minority knew that the current was the same in all three resistors (most went for the idea that the largest resistor had the largest current), and even fewer knew that the largest resistor had the largest voltage difference.

7 Many candidates correctly named the three different particles in atom for part (a), but only a small minority knew the effect of ionising radiation hitting an atom. The most popular incorrect answers were that the atom became radioactive, or that it died. It was disappointing to find that about half of the candidates were unable to state a use of ionising radiation for part (b).

8 This question was about the transmission of different types of ionising radiation through different materials. Most candidates correctly identified the materials which transmitted gamma and beta radiation, and some realised that none would transmit alpha radiation. Very few candidates were able to use the information provided in part (b) to write a sensible answer; although the question asked them to identify two sections of the badge which could be used to measure beta radiation, the majority of candidates chose just one. Of those who selected two sections, the vast majority plumped for those which transmitted beta radiation instead of one which did and one which didn't.

9 This extended writing question also appeared on the Higher Tier paper, so it was expected that Foundation Tier candidates would struggle to achieve full marks. Too many weak candidates managed to write an answer which contained no physics at all, earning no credit - usually attempting to justify the use of nuclear power to generate electricity. However, most candidates were able to explain why nuclear waste needed to be disposed of carefully, but few were able to describe how it could be disposed of, or discuss the disposal methods for the different types of waste.

A182/02 Physics A Modules P4, P5, P6 (Higher Tier)

General Comments:

Overall the demand of this paper was appropriate, as candidates were able to complete all questions in the time allowed. It was clear that the vast majority of candidates were suited to this Hiigher tier paper and that Centres had prepared them well for the style of questions, as there were few 'no response' answers.

The six-mark extended writing questions were, in general, attempted by all candidates. However, some candidates restricted their mark by only answering one aspect of the question. Other answers were overly long, with much repetition of the question and muddled presentation of physical ideas. A clear, well-planned and concise response can achieve a high mark.
The responses to questions requiring a numerical solution were usually accompanied by the working, which meant that candidates who obtained an incorrect final answer were still able to be awarded some marks if the working was correct. It was noticeable that a large number of candidates had difficulty manipulating numbers involving powers of 10. However, candidates need to be more aware of where using equations at the front of the question paper would enhance their answers.

Comments on Individual Questions:

Question 1 required candidates to use information presented on a velocity-time graph. Most candidates were able to answer at least three of the six parts correctly. The responses from a few candidates showed that they had confused the graph with a distance-time one.

Q1(a) Most candidates were able to read the time the race lasted within the tolerance set on the mark scheme. A few candidates thought the question was asking for the maximum velocity reached.
Q1(b) The majority of candidates selected the correct response, 'average'. The wrong responses were spread amongst all the other options.
Q1(c) Many candidates correctly linked this question with what was happening at the end of the race. However, those candidates who had confused this graph with a distance-time one thought that he slowed down around 3 s because the gradient became less.
Q1(d) The change in the gradient at 2 s was not noticed by many candidates which resulted in incorrect answers between 1 s and 2 s. A single time or a range within the limits 2 s to 2.8 s was accepted as correct. Other candidates confused maximum acceleration with maximum velocity.
Q1(e) This question was answered well. Incorrect responses included 'always accelerating' and 'shows positive correlation'.

Question 2 expected candidates to use momentum and kinetic energy equations given at the front of the question paper. Many did not and consequently there were many vague or incorrect responses.

Q2(a)(i) Many responses did not clearly differentiate between mass and weight. 'Heavier' was the most common answer and this only gained the mark if it was made clear that the ball had more mass. Those candidates who correctly selected and quoted the equation for momentum were awarded the mark.
Q2(a)(ii) This question was poorly answered by most candidates. Many candidates failed to use the fact in the stem of the question that the balls gained the same momentum. Very few candidates used the relevant equation for change of momentum in their answer. Incorrect

responses included increased force, discussion of the shape of the ball during the collision and answers that failed to state the effect on the force.
Q2(b)(i) This question was an overlap with the Foundation tier. There were many well set out answers with the correct numerical solution and a statement that the ball would not break the glass. However, candidates needed to justify their answer with the help of the calculation eg. '2.4J<10J' or 'ball only has 2.4J'. Those candidates who obtained an incorrect numerical answer either transformed the mass into weight or failed to square the velocity.
Q2(b)(ii) Few candidates knew that the momenta should be added because velocity is a vector. The most common incorrect answer was 0.4 (kgm/s) as candidates had subtracted the momenta. A few candidates wrongly tried to apply the change in momentum equation.

Q3 This was the first six-mark extended writing question. Many responses met the criteria for level 1 or 2 by discussing momentum or kinetic energy or forces during the run. However, very few candidates considered the actual jump and even fewer mentioned the time in the air, which was necessary in order to access level 3. Ideas about forces were very general and muddled and the connections between force, momentum and energy were often confused. Many answers lacked planning and repeated the same idea over and over again.

Q4 Both parts of this question were overlap with the Foundation tier. On the whole this question, on relationships, was answered well by the majority of candidates.

Q4(a) Many candidates drew a straight line on the graph. Some candidates thought that sketch meant that axes did not need to be labelled.
Q4(b) Responses were not explicit enough where the answer 'yes' or 'no' was given. In such questions, where there are two statements to be considered, candidates need to say to which one they are referring. Correlation was better understood than direct proportion. Some candidates tried to give reasons for the relationship rather than answer the question. There were a few good answers that described the square relationship clearly.

Q5 Candidates found this question, about electricity, difficult. The majority only scored 2 or 3 marks out of the 8 possible for the whole question.

Q5(a)(i) Many candidates chose the correct resistance of 3 (kΩ). The most common incorrect answer was 1 (kΩ).
Q5(a)(ii) A minority of candidates chose the correct answer.
Q5(a)(iii) The idea of potential difference being the work done on/by charge is generally not known by candidates. A few correctly mentioned work done by the battery on the charge passing through it, but even fewer went on to discuss work done by charge on the resistors. Many answers described how the pd is shared amongst the resistors without mentioning work done, or applied Kirchhoff's second law in terms of pd or merely quoted the question. Others tried unsuccessfully applying work done = force x distance to the situation.
Q5(b) About half the candidates selected the correct answer.
Q5(c)(i) The majority of candidates chose an incorrect answer.
Q5(c)(ii) This was poorly answered by most candidates. Many thought that the transformer did not work because it was a series circuit, or the voltage was too low, or because there was a motor in the circuit. Those who gave a correct response usually stated that transformers require ac, but some failed to state that the battery gave dc.

Q6 This question about a lamp filament was the second six-mark extended writing question. The majority of candidates failed to meet the criteria for levels 2 and 3 since they did not link the thinness of the filament to resistance (or a description of resistance) and to the production of light. Some candidates achieved level 1 by realising that the light emission was linked to the temperature of the wire or the heat produced. Many candidates wrongly thought that the connecting wires were covered in a material such as plastic or that they were too thick to let light escape.
Q7 Most candidates found part (b) more challenging than part (a).

Q7(a) The use of radiation where cells are killed seemed to be general well known. Few candidates failed to score any marks on this part. Over half the candidates gained both marks by choosing the three correct answers. There was no evidence of candidates choosing more than three options, though a few only chose two or one.
Q7(b)(i) Responses were often not creditworthy as candidates confused 'detect' with 'stopped by'. Such answers stated what gamma and beta did not go through but did not explicitly say which they passed through and therefore would be recorded by the film. There were also misconceptions that lead allowed gamma to pass through it, and that aluminium allowed beta.
Q7(b)(ii) Many of the responses that did not get awarded the mark stated a property of alpha particles (eg can only pass through a thin sheet of paper) but did not relate it to the badge. Candidates needed to say that alpha particles could not penetrate any of the window coverings in order to gain the mark. Some responses only mentioned that it could not go through card, but failed to mention the other window coverings.

Q8 Candidates found this question, about aspects of nuclear reactors, one of the most difficult on the paper.

Q8(a)(i) The majority of candidates failed to be awarded any marks for this question. There were some well-presented answers which showed all the working and successfully dealt with squares and powers of 10. A few candidates were able to rearrange $E=mc^2$ but then had difficult with manipulating the data. The use of standard form in answers is not widely used.
Q8(a)(ii) About half the candidates correctly stated that more coal would be needed, but only a very few also gave a correct reason. It was sometimes difficult to know whether a candidate meant coal or uranium when the response was 'it requires more'. Some candidates failed to address the question and wrote about fossil fuels or greenhouse gases or efficiency.
Q8(b)(i) This question produced the greatest number of 'no responses' with no attempt made by the candidate for either answer. More candidates successfully gave the proton number, 52, for Te than the mass number, 135. A common incorrect answer for the latter was 137, due to missing the 3 in front of the neutron.
Q8(b)(ii) The majority of candidates' responses failed to be awarded any marks. In many responses candidates did not use scientific terminology and ideas in explaining how fission reactions are controlled. They tried using everyday terms such as 'the coolant cools' or 'the coolant prevents an explosion' and 'the control rods control'. Many attempted to describe what a chain reaction is, but did not know that the particles released were neutrons; protons, electrons and atoms were mentioned. The function of the fuel rods was generally not known.

Q9 This question, about radioactive waste, was the third six-mark extended writing question. This was an overlap question with the Foundation tier. The best responses at level 3 were able to describe the different categories of waste, linking them to their method of disposal and recognising the harm to health and how it is caused by radiation. The responses meeting the criteria for level 1 addressed either the harm or disposal, but not both. Often the harm, such as cancer, was stated but not explained, and vague descriptions of disposal such as 'bury it' were given. The question elicited very long answers with a lot of detail that was not required. The term 'disposal' was not understood by some candidates. Some candidates wrote at length about the choices for and against nuclear power without addressing the issues in the question. Other candidates confused different types of waste with different types of radiation.

Controlled Assessment

Overview

This was the second session for the assessment of the 21C Science suite's 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 significant 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 before 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.

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