

**Additional Science A**

**Twenty First Century Science Suite**

General Certificate of Secondary Education **J242**

**OCR Report to Centres**

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**June 2013**

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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

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## Overview

This is the last examination series for the ‘mixed’ science papers, but many of the points raised in this report will be valid for candidates taking biology, chemistry or physics examinations in the next two sessions. This is because the separate-science papers follow the same specifications as the current science papers, and are designed to the same degree of rigour as these papers. It is therefore recommended that Centres look carefully at the Principal Examiners’ Reports for all examinations in the 21<sup>st</sup> Century Science suite – Science, Additional Science, Biology, Physics and Chemistry – together with the relevant papers, as there are generic recommendations which Centres will want to take account of in preparing for future examinations.

As in previous sessions, Examiners have commented that candidates appear to be more comfortable with the six-mark extended writing questions. Six-mark extended writing questions which asked the candidates to make suggestions were again better answered than questions which demanded recall.

As always, candidates should take especial care in reading the question. In the pressure of the examination it is very easy to make mistakes of interpretation, which can then severely limit the number of marks available to the candidate. Centres are also reminded that six-mark questions often demand that the candidates consider more than one aspect of a problem, and so examiners usually reserve the highest level marks for those candidates who clearly address all the required aspects. Centres are recommended to train candidates in strategies such as highlighting significant words to enable the candidates to identify the thrust of each question.

# A151/01 Twenty First Century Additional Science A (B4, C4, P4) Foundation Tier

## General comments

Most candidates had enough time to answer all the questions and made a good attempt to answer them all, including the six-mark extended writing questions - there were four other question parts that were omitted more often than the extended writing questions. Overall candidates expressed themselves well and showed they had engaged with the content of the specification.

## Comments on individual questions

**Q1(a)** Candidates were required to complete the word equation for anaerobic respiration. A large number were unable to recall the equation and many opted for aerobic rather than anaerobic respiration. As a result, there were a lot of answers with more than one word in each space.

**Q1(b)** Only a minority of candidates knew that anaerobic respiration takes place in the cytoplasm. This was true for candidates across the whole ability range. The most popular of the three incorrect responses was mitochondria.

**Q2(a)** Candidates were given the concentrations of carbon dioxide and oxygen in the air and asked to deduce the concentrations inside a leaf. Candidates were asked to 'Put one tick in each row', but some lost marks by putting more than one tick in a row, and this was sometimes one tick in each column, raising the question of whether they were thinking of a column as a 'vertical row'.

**Q2(b)** This was a six-mark extended writing question, and it was pleasing to see how many candidates were able to describe, albeit at a simple level, the co-dependence of plants and fish in terms of photosynthesis and respiration. They did not often use the names of the processes, although photosynthesis was mentioned earlier in the question. The wording of the question, with its emphasis on gases, may have helped many candidates, but some weaker candidates still opted to discuss feeding relationships. Answers would have been improved by an understanding that fish do not breathe.

**Q3(a)** There were three sentences about an enzyme to be completed by choosing the correct word. Candidates scoring 2 marks, for 3 correct responses, were in the minority.

**Q3(b)** For the substance, other than carbon dioxide, made by yeast during anaerobic respiration it was rare to see the answers ethanol or alcohol. Lactic acid was a popular answer, and bread was often seen. This question was omitted by a small number of candidates.

**Q4(a)** Candidates were asked to plot two points and then draw a line of best fit through the six points. The points were straightforward ones to plot, leading to a line that was not difficult to position. For the majority, plotting was accurate, and most candidates drew an acceptable line of best fit. However, some candidates did not plot the two points, some did not draw a line of best fit, and some drew a line, or more than one line, that was not straight. It was good to see very few dot-to-dot lines.

**Q4(b)** Candidates were asked for the concentration inside the potato cells at the start of the experiment. They were expected to check their graph to see when there was no change in length of the cylinders. There were very few correct answers. Many candidates chose zero, either because it was the first concentration given in results table, which they viewed as the 'start

of the experiment,' or because of the misconception that there was 'no concentration' in the potato at the start of the experiment. A few estimated 50% by saying that 0 was halfway between the readings of +1 at 40% and -1 at 60%, but for some reason did not realise that a better estimate was the point where their line of best fit cut the axis. Some candidates did not attempt this question.

**Q4(c)** Candidates were asked how Karen could improve her experiment to increase confidence in the conclusion. Many candidates showed that they knew some ways of improving experimental technique, such as repeating the measurements and taking an average. There were few references to reproducibility or to repeatability, but some references to reliability. However, some candidates suggested Karen should 'measure more accurately', and some did not attempt to answer.

**Q5(a)** Candidates were given the boiling points of chlorine and iodine and asked to select the boiling point of bromine from a list of values. The majority of candidates correctly chose 59°C. The most common incorrect response was 219°C

**Q5(b)(i)** Just under half of candidates correctly chose chlorine as the halogen of the three that was likely to make the best bleach.

**Q5(b)(ii)** Just over half of candidates correctly chose the greatest reactivity as the reason why it was likely to make the best bleach.

**Q5(c)(i)** This was very well answered, with the great majority of candidates able to use the periodic table to determine that it is bromine which has a relative atomic mass of 80.

**Q5(c)(ii)** The majority knew that chlorine has 17 protons.

**Q5(c)(iii)** Candidates were asked to put crosses, on a diagram of an atom with 3 shells, to show the electrons in an atom of chlorine. They answered this very well, with the majority gaining both marks. A very small number scored 1 mark for 17 electrons wrongly distributed between shells, and only a similarly small number failed to score a mark. Some candidates used dots rather than crosses, and these were sometimes difficult to see. Those candidates who arranged the crosses in a pattern made counting them easier for themselves and for Examiners.

**Q5(c)(iv)** Candidates were asked to explain what happens when a chlorine atom reacts with a metal and becomes charged. This was the hardest part of question 5 and only the stronger candidates answered correctly. There was a lot of confusion over the charge on an electron. Many thought that adding an electron gave the ion a positive charge. This was the part question that was omitted most often by candidates.

**Q5(c)(v)** Candidates were asked for the **word** equation for sodium and chlorine reacting to give sodium chloride, but many attempted to use **symbols**. Although this was not penalised, the symbol equation has to balance and so candidates almost always lost the mark. There was some of confusion between chlorine and chloride. Nevertheless, the majority of candidates gained a mark here.

**Q5(c)(vi)** Candidates were asked for the substance made when potassium reacts with chlorine, and most correctly answered potassium chloride. The correct formula was acceptable here, and was sometimes seen. Some candidates did not attempt to answer.

**Q6** Most candidates attempted this six-mark extended writing question and they scored across the whole range of marks. The question differentiated well. The best answers dealt with the 2 bullet points separately. Some candidates tried to address both points together and ended up getting confused. Some wasted time by describing the work of other scientists, although the extra detail concerning the other scientists and Mendeleev showed a real interest and

understanding. There were lots of well written answers worth 4 marks that showed some understanding of the reasons for the groups and the reasons for the empty places in the table. It was rarer to see a creditworthy explanation of why other scientists eventually accepted Mendeleev's ideas. Some candidates suggested this was because, 'It made things easier for them.' Even some of those who recognised that the newly discovered elements fitted the gaps, thought that scientists therefore preferred to use this table because they wouldn't have to go to the effort of re-drafting it to fit the new elements in, rather than understanding that this meant the pattern Mendeleev was suggesting was confirmed. Some candidates made clear they thought that scientists could make any number of new elements, only limited by their imagination and technical expertise. Their use of the words 'new elements' rather than 'newly discovered' elements may be adding to their misconception, and it would be good to discourage the description 'new elements.' Most candidates did not realise that there is no new element to be discovered unless there is a gap in the periodic table.

**Q7** Candidates were asked to look at the line spectrum of a sample and compare it with the spectra of sodium and potassium to decide if the sample contained sodium and/or potassium. Many weaker candidates did not get credit because of vague references to "looking similar" or "looking like" which did not refer to lines or patterns in the spectra. Many said that the sample and potassium had the same lines when they obviously don't. Some candidates realised that the sample had more than just sodium but didn't realise that it could have something other than potassium. Some candidates thought that you could have 'a bit' of sodium or potassium which would result in a few of the lines.

**Q8(a)(i)** Candidates were asked to select the best estimate from 5 possible values. The majority of candidates correctly calculated the mean value of the four reaction times and selected 0.20s

**Q8(a)(ii)** Candidates were asked to select the range of the results from four possible ranges. Again, the majority of candidates correctly gave the range to be 0.18s to 0.22s.

**Q8(b)** Candidates were asked what they concluded about the effect of the energy drink and to justify their answer using part (a) - the mean and the range of the results. Most candidates scored one mark for a conclusion about decreased reaction time or faster reactions. Unfortunately, some candidates confused time and speed, and lost this mark for saying, 'the reaction times increased making Ellie faster.' Many candidates did not gain any other marks, as their 'justification' was not based on the data from part (a), but on reasoning that the increased sugar had affected her. However, it was good to see that some candidates did attempt to use the data to back up their claims, although these responses tended to be very simplistic, for example, a direct quote of highest and lowest times, or of the two ranges. A minority of candidates scored for the 'new mean'. The scoring response that was seen most often was the fact that all the reaction times were less than the previous ones.

**Q8(c)** Asked to choose the explanation of why the ruler speeds up, almost half of the candidates correctly chose that gravitational potential energy transfers to kinetic energy.

**Q9** This six-mark extended writing question asked for an explanation of why larger crumple zones were more effective than small ones. There is no indication in the question of the purpose of a crumple zone, and most candidates achieved at least a Level 1 mark by explaining that, in a collision, the larger crumple zone resulted in less injury to the occupants. Some of those candidates that failed to get this far mistakenly thought a crumple zone would result in less damage to the car. Another misconception among weaker candidates was that there would be less damage to the larger crumple zone, than to the smaller crumple zone, although some of these may have meant to say less damage to the passenger-compartment/safety-cage part of the car. Overall, though, a pleasing number of candidates seemed to grasp that the increased time for the collision is a key part of how crumple zones reduce injury in a crash. Many candidates gave a Level 2 response explaining how the crumple zone worked; they explained that increasing the time of the collision reduced the force. Fewer candidates went on to link the

correct physics to the effect on the occupants to achieve Level 3 marks. Marks were often lost because of muddled terminology - forces and kinetic energy getting slower, or momentum being absorbed. There were also some candidates who were sidetracked by discussions of surface area and pressure.

**Q10(a)** Stronger candidates had no difficulty calculating the speed of the car from the time of 0.40s and distance of 8.0m. Weaker candidates sometimes multiplied the numbers and sometimes divided the time by the distance. Some were also confused by the decimal places and the answer 2 was often seen. Very few candidates showed any working, so the number of candidates scoring one mark for a correct equation was very small.

**Q10(b)** The large majority of candidates chose the correct speed time graph, showing acceleration away from the speed camera.

**Q11(a)** Candidates were asked to add the labels 'friction' reaction' and 'weight' to the diagram. The large majority had no problems with this. A few did not use the word list under the question and added words of their own choice.

**Q11(b)** This question asked for the size and direction of the force on Jim from the box, with an explanation. Candidates could answer by adding to the diagram or by writing underneath. This question proved very difficult and many candidates scored zero, while some left this part unanswered. The weight of 800N cause problems as candidates thought this was important and often subtracted or added it to the 200N. Many thought that the force from the box would be less than 200N – otherwise the box could not be pushed forward. Some candidates realised that the force was towards Jim and gained this mark for an arrow on the diagram or a statement in the text. A small minority recognised that the force must be 200N.

Responses that went on to describe this as an interaction pair were very rare and the third mark was rarely awarded.

## A151/02 Twenty First Century Additional Science A (B4, C4, P4) Higher Tier

### Comments on individual questions

**Q1** In this first of the three six-mark extended writing questions, candidates interpreted the graph of enzyme activity with confidence and scored well. Whilst a few candidates described the shape of the graphs without reference to either temperature or activity, the vast majority clearly understood that temperature was an important factor. However, while candidates are very used to graphs with temperature as the dependent variable, some found temperature as the *independent* variable much more difficult to interpret. There were many statements such as “enzyme A is quicker to rise in temperature” or “enzyme A reaches its maximum temperature at 13°C”. Stronger candidates picked up on the second part of the command line of the question and went on to *explain* the activity, usually in terms of denaturing. Denaturing itself was often well described, though the temperature at which the enzyme does denature was much less well understood – many candidates suggested that the enzyme becomes denatured as soon as the optimum temperature is exceeded. A wide range of candidates occasionally mis-read the scale of the temperature axis and stated that “Enzyme A peaks at 10.7°C”

**Q2a** The graph was drawn well – the usual mistake was to mis-read the scale on the y-axis and so mis-plot the two points. Examiners were cheered to see that very few candidates drew a curve or a dot-to-dot line.

**Q2b** Osmosis is a difficult topic, and the majority of candidates had problems understanding the nature of this experiment. There was a very common assumption that the sugar in the solution permeates into the potato. This was often stated explicitly “because the sugar hasn’t started to go into the cell’. The most common suggestion for the concentration was 6.2, i.e. not the concentration but the percentage change in length for zero sugar concentration. Some of the strongest candidates could see that the concentration inside the cell was given by the intercept on the graph. Examiners used the value of the candidate’s own intercept to mark this question, and there were candidates who gave a number which was close to, but not exactly the same as, their own value.

Several candidates suggested that the value should be 50 because the length of the potato chip was 50mm. A significant number of candidates did not attempt this part.

**Q2c** Most candidates able to give at least one valid suggestion for improving the experiment. ‘Leave it for longer’ and ‘weigh the potatoes’ were the most common suggestions not to be given credit.

**Q3a** The ability to write the equation for photosynthesis proved to be an excellent discriminator. Candidates tended to either know it well, in which case they scored both marks, or have such a confused understanding that they scored zero. Weaker candidates often did not attempt this part.

**Q3b** Lack of nitrogen was the most often identified correct reason, though candidates who suggested that the amino acid needed nitrogen oxide were not given credit. “There would be elements left over” and “the formulae were not balanced” were the most common answers. Weaker candidates often did not attempt this part.

**Q3c** Some candidates quoted the general limiting factors for photosynthesis rather than identify the specific limiting factor in this case. Consequently, light was often given as the answer despite the information that the light levels had been kept constant. pH was also sometimes suggested.

**Q3d** Candidates were more likely to choose the last two responses correctly than the other two

**Q4** The idea of match between the spectra was well understood, and most candidates made specific reference to the lines. The main mistake was to imply that only some of the sodium spectrum matched the sample. Candidates were expected to consider the match of the whole of the sodium or potassium spectra against the sample, so those who looked for a match against the bold lines only gained credit for recognising the importance of the lines.

**Q5a** This question discriminated well with stronger candidates correctly identifying the number of protons and of neutrons in the chlorine atom.

**Q5b** As in the previous part, stronger candidates were able to derive the electron arrangement of fluorine, either from memory or from the Periodic Table at the back of the paper. The most common incorrect response was to repeat the electron configuration of chlorine as given in the stem of the question. Most other incorrect responses did at least start 2.8... , which showed a residual appreciation that the most significant parts of the electron configuration were those in the outer shell. Weaker candidates often did not attempt this part.

**Q5c** Many candidates were able to show a partial understanding of how halogen atoms turn into halogen ions, and the stronger candidates went on to develop this into a three mark response. Weaker candidates often did not attempt this part.

**Q5di** Candidates have great difficulty with the term ‘state symbol’; as in previous years, very few candidates knew what they are. Most candidates tried, unsuccessfully, to write the chemical formula for each of the substance in its box, or put numbers into the boxes. Even those who did use state symbols often used “g” for chlorine and “s” for potassium iodide solution.

**Q5dii** Equation balancing is an important part of chemistry, and so questions on equations are put in every year. As in previous years, very few candidates knew what to do. The formulae were all taken from specification statement C4.1.28 as ones that the candidates should know, but not only did candidates suggest formulae such as  $KCl_2$  and  $PI$ , they often wrote chlorine and iodine as monatomic. An surprisingly high percentage of candidates did not even attempt any form of answer.

**Q5diii** Stronger candidates were able to use their understanding of the link between chemical properties and electron configuration to explain why chloride ions are not very reactive. As this question was intended to be stretching, Examiners were not surprised to see that weaker candidates often did not attempt this part.

**Q5e** The reason for the conductivity of electrolytes was well understood by many candidates. ‘Potassium is a metal and metals conduct’ was the most common incorrect response from weak candidates.

**Q6** This was the second of the six-mark extended writing questions, and was again well answered. Examiners were impressed at the number of candidates who dealt with both aspects of the question, the way that Mendeleev’s table could accommodate the new elements and also the effect that the discovery had on the scientific community. Strong candidates who made several points in support of their answers tended to score all six marks. Many candidates incorrectly claimed that Mendeleev ordered the elements by their atomic number. Such statements were ignored.

**Q7** Many candidates realised that the effectiveness of crumple zones necessitated reference to both the occupants of the car and to concepts such as force, time and momentum. The stronger candidates realised the link between time of collision and size of force exerted. Weaker candidates often limited themselves to a surface area argument, a few clearly articulating their misunderstanding by then referring to pressure.

**Q8a** This question was very well answered with candidates clearly comparing the calculation of the best estimate with the data in the table.

**Q8b** There were many references to why the drink has an effect without using the data from the tables. The question asks candidates to use data from the tables, so to achieve the highest marks both the tables had to be referred to in some way. Frequently, those candidates who did quote numbers quoted the fastest and the slowest, or the first and the last, rather than considering the size of the range in each case. A sizeable minority of candidates showed considerable confusion between time of response and speed of response with statements such as “her average time of 0.27 seconds increased to 0.18”

**Q8c** Many candidates realised that it is the gradient of the line which gives an indication of speed, and stronger candidates appreciated that it the increase in gradient which indicates acceleration. On this occasion Examiners accepted words such as ‘steepness’ as an alternative to gradient. Some candidates’ descriptions of the graph would have applied equally well to a line showing constant speed, so were not able to gain credit.

**Q9a** Many candidates realised that the acceleration would be  $4\text{m/s}^2$ . A small group gained the second mark by stating that the acceleration would be  $-4\text{m/s}^2$ .

**Q9b** Many candidates of all abilities found it difficult to identify the correct distance-time graph for the lorry as it slowed down.

**Q10a** Gravity pushing down was the best understood force. While most candidates recognised that friction was another of the forces, very few could clearly state the direction in which it operates. Answers such as ‘friction opposes movement’ were not enough to gain credit in this case. Some candidates were able to gain credit just for appropriate labelling of the diagram. Weaker candidates gave no directions at all.

Examiners accepted upthrust as a description of the reaction force, and this decision meant that it was better answered than friction. Weight and gravity were often suggested to be operating in different directions. Many candidates suggested ‘air resistance’ to go along with gravity and friction, showing the problems that they had with placing these forces into a realistic context.

# A152/01 Twenty First Century Additional Science A (B5, C5, P5) Foundation Tier

## General comments

This paper was well answered by the majority of candidates. The questions differentiated effectively. Almost all questions had responses and there was no evidence of candidates being short of time.

Objective questions were generally well done, but the shorter free-response questions, particularly the mathematical ones, were found challenging and were often answered superficially. In these papers it is important that candidates recognise that a mathematical question will often be extended, needing not only a calculation (which could involve more than one stage) but also an evaluation of the results.

Candidates had a clear understanding of ideas about science and questions on these were well answered throughout the paper.

Candidates should be encouraged to attempt every question on the paper. A proportion of candidates on this paper gave no response to a number of the extended writing questions which, of course, limits their maximum mark.

## Comments on individual questions

- 1
  - (a) Most candidates were able to write the word equation of the reaction. The most common error was to confuse carbon monoxide and carbon dioxide, whilst a very few did not use the words provided in the answer.
  - (b) Most candidates were also able to give the number of iron atoms in a formula. The common wrong answer here was to count all the atoms in the formula.
  - (c) This question was well answered with almost all candidates giving the correct formula mass for carbon monoxide.
  - (d) This question proved to be more difficult. Few candidates knew how to work out the mass of an element in its formula mass. Some did not show working so, when a wrong answer was given, it was impossible for them to score any marks for their method.
  - (e) Few candidates knew that changing a metal oxide to a metal was reduction. The most common wrong answer was oxidation.
  - (f) Only a few candidates used the idea of the relative reactivity of aluminium, carbon and iron. Often there were statements such as 'aluminium is very reactive' rather than a comparison between the elements.
  
- 2
  - (a) Few candidates knew that precipitates form because an insoluble chemical is made. All the wrong answers were seen.
  - (b) Both parts of this question were discriminating. Some candidates did not understand that the information was on a data sheet found at the front of the paper.
    - (i) Both correct answers and no others had to be given to score the mark. Weaker candidates often picked ions that formed white precipitates from the data sheet irrespective of whether sodium hydroxide or another reagent had been added. Other candidates only picked one of the two correct answers.
    - (ii) More candidates were able to find the correct ion in this part. There were still many obvious guesses where candidates had not used the data sheets.

- 3** This was the first six-mark extended writing question on the paper. A minority of candidates failed to make any response at all. Those that did usually scored at least 2 marks for the question. Properties needed for electrodes used at high temperatures were known and linked to graphite. However, it proved more difficult to link graphite to lubrication. Many thought lubricants had to be liquid whilst others tried to describe how graphite is used for making locks & hinges. There was a great deal of confusion about the structure and bonding in graphite which meant candidates found it difficult to link its properties to its structure.
- 4** Almost all candidates attempted this question on data and there were some excellent answers. Weaker candidates were confused by what the graphs showed and whose idea they supported.
- 5** Again, a significant number of candidates made no attempt at this six-mark extended writing question. Others chose to describe how wind turbines converted kinetic energy into electrical energy and failed to score. Many candidates were able to label the magnet and the coil and recognise that the magnet had to spin for electricity to be generated. However, very few could correctly link the two together by writing about induction and hardly anyone knew about the core.
- 6** (a) This question was well answered with almost all candidates scoring at least one mark. The component whose function was least well known was the voltmeter.  
(b) Very few candidates realised that they needed to do calculations in this question. Most discussed the relationship between current and potential difference shown in the table. Resistance was not mentioned. Candidates should realise that if a question suggests using calculations then these are needed for the marks.  
(c) Both parts of this question were well answered with many candidates scoring both marks. Some weaker candidates gave Davina as the answer to part ii showing confusion between checking and accuracy.
- 7** (a) Another well answered question with most candidates able to calculate the heating power of a circuit.  
(b) Most candidates knew that adding an extra cell to the circuit doubled the potential difference fewer knew the effect of that on the fixed resistor or the current. This limited the majority of candidates to one mark.
- 8** (a) Many candidates were able to name an appliance containing an electric motor and describe what the motor did. Some weaker candidates believed all electrical appliances had motors and gave incorrect examples such as kettles and irons. They did not understand that a motor is needed for movement.  
(b) Few candidates could explain how an electric motor works with many explaining a generator instead of a motor. Some candidates just tried to write sentences that included the key words; these answers gained no marks.
- 9** (a) This question about DNA was well answered with almost all candidates scoring at least one mark. The most common error was in the third sentence. Many did not know that the code for a proteins is in the order of the bases.  
(b) (i) Most candidates gained both marks on this calculation. Again, lack of working meant it was difficult to award one mark for method.  
(ii) There were many very good answers to this part with candidates giving two ways that confidence in the tests could be increased.
- 10** (a) Most knew that the nucleus divides in mitosis, but were unsure that 'chromosomes separating' was the other process. The most common wrong answer was 'chromosomes being copied'. Although two answers were specified in this question, some candidates lost marks by ticking one or three boxes.

- (b) (i)** This calculation proved discriminating with the strongest candidates obtaining the correct answer.
  - (ii)** This part was more difficult. Many candidates did not seem to understand the statement 'more than 0.1'. A number of candidates thought that 0.08 was greater than 0.1.
  - (iii)** Many of those candidates who had the correct answer to part(i) were unable to use the graph correctly to find the answer to this part.
- 11** Methods for taking cuttings were often vague and inaccurate. Sometimes they were not mentioned at all, which limited a candidate to 2 marks in this six-mark extended writing question. There were some good explanations of why cuttings should be taken from resistant elms instead of sowing seeds though a number of candidates incorrectly gave cost reasons and failed to score. A few candidates thought trees had stem cells.
- 12** The final question asking for sentences on stem cells to be completed was well answered. Most candidates scored 2 or 3 marks on this.

# A152/02 Twenty First Century Additional Science A (B5, C5, P5) Higher Tier

## General comments

As always, candidates found the physics and chemistry questions harder than the biology ones. However, they are getting better at answering the six-mark extended writing questions than in previous sessions, although they still tend to write about what they think know rather than what the question asks them to do.

In general, candidates are not good at doing calculations. In fact, they seem to actively resist doing them in physics. Candidates assume that any calculation involves choosing a rule and substituting the numbers, and don't recognise that some calculations require two steps to obtain the final number.

## Comments on individual questions

**Q1** This question was about the production of metals from ores and proved to be a far-from-easy start to the paper. Only a minority of candidates could name the process of reduction for part (a). For part (b), the vast majority of candidates were unable to write down a correct symbol equation, with many assuming that the iron product was  $\text{Fe}_2$  instead of  $\text{Fe}$ . The calculation of part (c)(i) proved to be difficult, with many candidates appearing not to recognise the term **gram formula mass**. Despite the linking of parts (c)(i) and (c)(ii), only a minority of candidates used the reduction in mass to explain the environmental advantages of processing ore close to mines. Many just described the environmental impact of transport. Part (d)(i) was about the extraction of aluminium from impurities in iron ore. Many candidates got carried away with the context and suggested that since the Vikings didn't know about aluminium, they couldn't extract it. Other candidates suggested that there was too little to bother with, and only a small minority realising that aluminium was too reactive to be reduced by carbon. However, strong candidates had no trouble in writing down electrolysis for part (d)(ii).

**Q2** This question was about correlation and cause. Although most candidates were able to describe the correlation shown by the graphs and give one reason why they might not be causally linked, candidates often failed to give enough detail to earn the third mark. Candidates need to realise that if three marks are available for a question, they would be wise to say three separate things in their response.

**Q3** Despite all the information being given on page 3 of the examination paper, too many candidates simply listed the ions which had been added to test the mine effluent, instead of using the results of the test to identify the ions. However, as many candidates managed to earn full marks as earned none, with a significant minority losing marks by confusing carbonate with chloride.

**Q4** This six-mark extended writing question tested the ability of candidates to identify important properties of a material from a description of its use and relate that to its structure. It was well answered, with half of the candidates earning half marks. The majority of candidates were able to identify one property (usually the high melting point) and explain it in terms of the strong covalent bonds between the atoms. (A significant proportion of candidates referred to ions instead of atoms, indicating a poor understanding. Only the strongest candidates identified and explained the other property as well (high electrical conductivity - carbon atoms have four electrons in the outer shell but only three are required for covalent bonds)).

**Q5** This was the first of the physics questions on the paper. The majority of candidates earned no marks for part (a), not recognising that this was a two-step calculation. They assumed that they should be able to calculate the power directly from the voltage and resistance and, failing to find a suitable relationship on page 2 of the examination paper, made up their own and earned nothing. Part (b) proved to be even harder, with candidates of all abilities seeming to earn the mark at random.

**Q6** Only a minority of candidates earned any marks at all for part (a), with most of them opting to place the diode closer to the battery to increase the current in it. Even fewer bothered to use the data of part (b) to calculate the resistance of the diode, with the majority of candidates describing the correlation between voltage and current for no marks. This was despite the clear indication in the question that calculations would be necessary. Only a minority of candidates correctly identified the explanation for part (c)(i), with most of the others opting for the description of the correlation instead. However, nearly all candidates were able to identify the proposed improvement to the experiment.

**Q7** This six-mark extended writing question asked candidates to explain the alternating current produced by a generator. Although it was intentionally designed to differentiate between candidates operating at grades A\*, A and B, the quality of most responses were poor. Although many candidates could identify the important parts of the generator and state that their relative motion was responsible for the current, few could explain the voltage across the coil in terms of the change of magnetic field within it. A significant number of candidates suggested that the charged ends of the magnet pulled and pushed the electrons in the coil, confusing electromagnetism with electrostatics.

**Q8** This proved to be the easiest physics question on the paper. Nevertheless, only a minority of candidates earned full marks, suggesting that even the strongest candidates have a shaky understanding of static electricity.

**Q9** Many weak candidates ignored the instructions and drew four lines instead of just two. Only half of the strongest candidates could correctly identify the roles of the magnet and the commutator in an electric motor.

**Q10** This was the first of the biology questions. Part (a) differentiated well, with many weak candidates unable to remember that A links with T and C links with G. The majority of candidates could identify both correct statements about genes for part (b) and the calculation of part (c)(i) was correctly done by most of them. However, although most candidates could justify the money spent on researching a fatal disease for part (c)(ii), many lost a mark by not explaining the ubiquitous nature of the common cold without relying on the word common.

**Q11** This was the last of the six-mark extended writing questions, and it also appeared on the Foundation Tier paper, so was intended to be much easier than the other two on this paper. In practice, too many candidates failed to provide much detail in their description of the method (often failing to mention even planting the cutting in soil) and spending a lot of time explaining the science behind the cutting's ability to grow into a complete plant - which they were not asked to do. Although strong candidates were able to invoke ideas of genes and clones to justify the use of cuttings instead of seeds, weak candidates often stated that the cutting would grow into a tree which was identical to its parent - not only untrue, but not a scientific explanation.

**Q12** Part (a)(i) required candidates to read data from a graph and do a calculation with it. A large minority of candidates could not earn any marks at all for their attempt. Part (a)(ii) was understandably more difficult, requiring candidates to understand what the graph was showing, rather than just substitute numbers into a rule. The vast majority of candidates thought that chromosomes are copied during mitosis for part (b), suggesting a very poor grasp of the whole process of cell division. However, the majority of candidates were able to identify both correct statements of part (c) about the effects of auxin on shaded plants.

**Q13** Although most candidates could identify one correct statement about adult stem cells, only a minority could identify both. Many thought, incorrectly, that adult stem cells can grow to form any tissue.

# A153/01 Twenty First Century Additional Science A

## General comments

Six-mark extended writing questions are now being done with greater confidence, and greater success, than in the first examinations to feature them, and there are fewer scripts where these questions have been omitted. Centres are to be congratulated on their candidates' greater facility with these questions. However, less well-prepared candidates often limit the marks they can achieve to Level 1 by limiting their answers to one aspect of the question rather than the two or three which need to be addressed.

Questions involving the analysis and evaluation of data still prove very demanding for many candidates. In these questions it is essential to read the instructions in the question carefully, and to ensure that answers make use of the data given.

Viewed in subject terms, candidates were most successful on average in the Biology questions and least successful on the Chemistry questions. Candidates did not seem to have found the paper too long.

## Comments on individual questions

### 1 (Sterilising fruit)

Although the specification clearly states 'recall how ionising radiation can be used... to sterilise food' few candidates seemed familiar with the context given in this six-mark extended writing question. The difference between contamination and irradiation was not understood by many candidates, who were concerned that the radiation in the food presented a safety risk to consumers. Most candidates made reasonable comments on the safety risks to workers, but many thought that this factor meant that the sources used were of very low intensity, whereas the opposite is in fact the case.

### 2 (Technetium tracer)

Very few candidates attempted to use the data in the graph for part (a). Ideally, they should have drawn a best-fit curve and used it to find the half-life of the sample. Part (b) was generally well done, although many candidates thought a medical tracer was used for treatment rather than diagnosis

### 3 (Background radiation)

This question was well done by most.

### 4 (Parts of the atom)

Three-quarters of the candidates scored 2/2 here, with the remainder mis-placing one part of the atom.

### 5 (Jenny's stroke)

Parts (a) and (b) were well remembered by most, but (c) proved a little harder. Many candidates apparently did not like putting 'Dawn' as an answer twice, and so replaced their choice for part (i).

### 6 (Impulse speeds on neurons)

The interpretation of the data tested in part (a) was well done by most, but few candidates had learnt the role of the fatty sheath of the neuron.

**7 (Blink reflex)**

Many candidates attempted to answer the six-mark extended writing part (a) without any references to parts of the reflex arc, which did limit them to Level 1 marks. Even though this is not a reflex arc involving the spinal cord, answers which assumed that it did were accepted, as that is what candidates will have learned for reflex arcs. A number of candidates confused the parts of the nervous system with their functions, confusing 'neuron' with 'impulse'. In part (b), many candidates found it hard to express their meaning, confusing speed and time, and it was often hard to award marks where the examiner felt that the candidate did have some understanding but that the answer was too confused to credit.

**8 (Pavlovian pigs)**

Part (a) was well done by most, but in (b) the lack of detail restricted many candidates to one or two marks – they should have stated that food made the pigs salivate, but the association of food with the yellow bucket, over time, conditioned them into associating the two..

**9 (Acid-alkali titration)**

All parts of this question were well answered, with the exceptions of part (d) (name two ways of measuring pH) and the two parts involving graphs. In part (f)(i) candidates should realise that, for 3 marks, it is not enough just to write 'the pH goes down', and in part (g) only the strongest candidates recognised the energy levels in an exothermic reaction.

**10 (Reaction rate)**

This six-mark extended writing question was overlap with the Higher tier paper. Very few candidates realised that the initial plan was flawed and either repeated the information in Sarah's notes, possibly with minor changes, or suggested extra variables to consider. The strongest candidates generally suggested repeating the measurements for each volume of acid, keeping the mass of marble chips the same and making measurements for different volumes of acid. Only seldom was an answer seen which indicated that the candidate realised that Sarah's plan did not involve changes in concentration, which the experimental brief had demanded.

# A153/02 Twenty First Century Additional Science A

## General comments

This was the first time that the contents of the modules B6, C6 and P6 have been examined using six-mark extended writing questions. The majority of candidates attempted all of the questions and there was no indication that shortage of time was an issue.

Candidates demonstrated that they had secure knowledge of many aspects of the specification such as identification of safety aspects whilst using radioactive materials, how repetition strengthens neurone pathways, correct use of terminology of events at a synapse and factors affecting the rate of a chemical reaction.

Candidates performed less well on areas involving the processing and interpretation of data, including calculations of radioactive half-life, risk, nuclear equations, nuclear reactions and making decisions about science and technology.

## Comments on individual questions

1 In the first six-mark extended writing question, candidates concentrated mainly on safety aspects rather than procedures involved. The most common correct response was to link gamma radiation to the killing of micro-organisms. Very few candidates appreciated the penetrating nature of gamma radiation in relation to sterilising fruit and rarely was there mention of the importance of the packaging in the sterilisation process.

2 In part a) candidates found this question very challenging. Very few candidates made use of the graph in order to work out the half-life of the sample. The most common marking point was to compare the half-life of the sample to the half-lives provided for technetium and molybdenum.

In part b), the majority of candidates recognised that cells will be damaged/killed by the technetium but there were common misconceptions in terms of the action of technetium as a radioactive tracer. Many candidates thought that technetium could be used to kill cancer cells or could detect radiation within the body.

In ci) the majority of candidates did not understand the difference between contamination, radiation and irradiation, common incorrect responses discussed radiation being 'breathed in'. The majority of candidates missed the point about discussing the role of the rubber gloves in preventing contamination by not allowing the source to come in direct contact with the skin. In cii) candidates found it challenging to provide two correct responses for one mark, the most common correct responses were that the risks are small and that the workers could help patients.

In ciii) it was rare to see the correct response (Alan), the most common incorrect response given was 'Davina.' Ideas about science within P6, in particular risk, are areas that Centres need to provide more opportunities for candidates to develop their understanding.

3 In part a) the calculation of risk was usually processed incorrectly to give the most common incorrect response of '80'; the correct response was '40'. In part b), the correct response of '136' was given more frequently, which showed that many candidates had secure knowledge of sub-atomic particles linked to the atomic number and mass number of an atom. Part c) was an effective discriminator for stronger candidates as only the stronger level candidates could manipulate the nuclear equation successfully.

- 4 In part a), there were very few correct responses, revealing a lack of understanding of the fission process. Despite the equations given at the front of the examination paper, very few candidates selected the correct equation to answer part b) and so the correct response was very rarely produced.
- 5 In part a), an answer within the correct range was frequently given and there was evidence of correct processing of the graph. To ensure greater accuracy, Centres should encourage candidates to use a ruler when drawing construction lines on to graphs. Candidates found part b) very challenging, with very few correct responses linking the data to the lack of a fatty sheath on the neurone.
- 6 In part a), it was pleasing to see that the majority of candidates could give a correct example of a reflex action in a simple animal to aid its survival. Part b) was very well answered with many candidates gaining both marks.
- 7 In part a), candidates showed secure knowledge of the terminology used for events at the synapse. However, part b) caused more issues in terms of being able to correctly sequence the events at synapse, a good discriminator for stronger candidates.
- 8 Part a) was the second six-mark extended writing question. The question assessed recall of the topic 'How do humans develop more complex behaviour'. The majority of candidates were able to identify either a feature or a relevant mechanism. There were some common misconceptions that damaged neurones will regrow and few candidates were able to appreciate that the new pathways bypass the damaged area caused by the stroke. There were many references to long and short term memory and feral children which, although correct, did not score marks as they were irrelevant to answering the question posed. Part b i) displayed greater understanding of processing data with majority of candidates providing the correct response- 30,000. 8bii) Justification on whether to go ahead with a campaign to encourage women to eat less salt or not was an area candidates found difficult. This is another topic in 'ideas about science' for Centres to provide more opportunities for candidates to develop their skills. 8c) The fact that the answer to both parts of c was the same scientist (Dawn) clearly confused a lot of candidates and a number of responses showed Dawn crossed out for part i) to be replaced with an incorrect response.
- 9 In part ai), majority of candidates were able to identify from the graph the correct volume of  $20\text{cm}^3$  but the explanation mark was rarely awarded, many just stating this is where pH 7 was rather than discussing the sudden drop in pH of the graph. 9a ii), despite the calculation being provided, few candidates were able to process the data correctly to provide the answer 3.2. 9bi) was an effective discriminator for the strongest candidates as vast majority of candidates scored 0, the most common correct response was to place the reactant and product the correct way round. 9bii) was also a good discriminator as only the strongest candidates were able to write the correct ionic equation.
- 10 Part a) is the third six-mark extended writing question and is the one common to the foundation tier. Candidates struggled with this question and few Level 3 responses were seen as the candidate had to appreciate that concentration had not been investigated to gain 5 or 6 marks. Common marking points included ideas about control variables, repetition and extending the range of volumes. Candidates who discussed doing additional tests with new variables did not score marks. 10b), only a small number of candidates were able to give the correct formula for calcium chloride. 10ci) processing graphical data again presented an issue, with only the stronger candidates correctly calculating the rate to be 0.8. 10cii) only the stronger candidates could provide the correct units of rate of reaction. 10di and 10dii) were both well answered, demonstrating that candidates have secure understanding of the factors that affect the rate of a chemical reaction.

# A154 Twenty First Century Additional Science A

## Overview

This was the first session for the assessment of the Twenty First Century Science suites Investigation controlled assessment. There were significant changes to the structure and assessment criteria for the investigation from the previous specification. Many centres managed the transition from the old specification very successfully, demonstrated a good grasp of these changes and criteria. However a disappointingly large proportion of centres had their marks altered this session, many with large scalings. The most common cause of significant changes to centres marks related to the hierarchical nature of the marking criteria, details of which are addressed below.

## Administration

Documentary evidence of internal standardisation was also supplied in a large number of instances, but for many Centres, this was not provided. Much 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 controlled assessment cover sheet to the front of each candidate's work, which always causes problems to 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. 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. Candidates should not be allowed unreasonable amounts of time and It should be impressed upon candidates that producing reports is an exercise in conciseness.

## 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 criterion 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 at a given level then the higher of the two marks is awarded. Where the candidate meets some of the criteria at 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 Twenty First Century 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.

At the highest levels (7-8 marks) it is important that candidates consider all relevant factors. 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 candidates 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, 'there were only 5 different strength lens available', based on safety issues, '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

candidates 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 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 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.

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 candidate pooling data with other candidates 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 marks. 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.

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 strand **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. Candidates 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 included 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 strand **Sa**, as strand **Sa** is carried out under conditions of low control whereas strand **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 strand **Ea**. Different techniques or experiments that will provide additional data to assess the hypothesis are required for this strand.

## Sources of Support

In addition to this Principal Moderator's Report, OCR also offers several avenues of **free** support, including:

- 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.
- OCR also offers 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, Centres are encouraged 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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