OCR
Oxford Cambridge and RSA

GCSE

Science A

Twenty First Century Science Suite

General Certificate of Secondary Education **J241**

OCR Report to Centres June 2016

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

OCR will not enter into any discussion or correspondence in connection with this report.

CONTENTS

General Certificate of Secondary Education

Science A (Twenty First Century) (J241)

OCR REPORT TO CENTRES

A161/01 – Science A Modules B1, B2, B3 (Foundation Tier)

General Comments:

Most candidates were well prepared for this paper and made a good attempt at answering all of the questions.

It was evident from the six-mark extended writing questions that candidates were trying to address all sections of the question set and many were clearly well prepared as to how to structure their responses.

On the whole, candidates limited their responses to the available spaces, which was pleasing to see.

The paper was challenging and discriminated well between candidates. There was no evidence that candidates ran out of time on this paper.

Comments on Individual Questions:

Question 1
1(a) In this question candidates were required to select the correct word to complete three sentences to explain how genes function. The majority of students scored one mark for this question. The most common error being in the first sentence where many candidates thought that genes were **cells** that describe how to make proteins.

1(b) Candidates were asked to identify which cells in a human usually contain pairs of chromosomes. Many candidates selected the correct response. The most common error observed showed that candidates thought that all human cells contained pairs of chromosomes.

Question 2
2(a) This question required an understanding about clones. The majority of candidates scored at least one mark for this question, often for the correct identification that ‘Clones A and B would have identical genes’; many candidates scored both marks. Unfortunately, some candidates did not tick two boxes and were therefore limited to one mark. Centres are asked to remind students to read the instructions carefully to avoid making such mistakes.

2(b) This question was on the whole answered poorly with few candidates gaining marks. Those that did score on this question correctly identified bulbs as a way in which plants could make clones. Many candidates incorrectly identified ‘cuttings’ and ‘seeds’ as a method of making clones, or simply repeated the stem of the question, indicating that the candidates had not fully understood what the question had asked or that the topic was not well understood. There were a number of candidates that did not attempt this question.

2(c) This was the first of the six-mark extended writing questions. It is pleasing to see that the candidates are now confident in tackling these questions and that many have developed good strategies to ensure that all parts of the question are answered. Candidates were asked to explain why identical twins look similar, but will not always look exactly the same. The majority of candidates scored between 1 and 4 marks on this question, with a large proportion scoring at Level 2. Candidates were able to correctly identify similarities and differences, though similarities were discussed less frequently. Candidates were able to express well that the differences were observed due to the environment and gave a good range of examples.

Candidates struggled to explain why the twins looked similar. Many referred to the twins having the same genes rather than the same alleles and unfortunately were therefore unable to gain marks. Centres are asked to ensure that when discussing similarities that the distinction is made between genes and alleles. Some candidates were confused and thought that the twins would have different genes/alleles and discussed the inheritance of dominant and recessive alleles from the parents. Candidates did seem aware that something 'split' and frequently made reference to the egg splitting, fertilised egg, or embryo splitting which was rarely mentioned. Genetic variation was not well understood by most candidates.

Question 3

3(a)(i) This question on the whole was answered well with many candidates selecting 0.87. The most common incorrect answer was 1 in 87.

3(a)(ii) Many candidates failed to score on this question. Many thought that Jane either had cancer or had a low chance of getting cancer; very few seemed to realise that it would in fact make it likely that she would get cancer. Few candidates were confident enough to say that she was certain to get cancer. Centres should be encouraged to develop candidates' understanding of probability.

3(b) This question asked candidates to consider whether Jane should have surgery to remove the breast tissue. Candidates found this question challenging. The majority of candidates scored 1 mark for this question; few candidates scored 3 marks. The responses indicated that the candidates did not understand that this was preventative surgery and not surgery to remove cancerous tissue. Many candidates seemed to think that Jane had cancer and that the surgery was to remove the cancerous tissue. As a result, many incorrectly identified that all the tissue may not be removed and that the cancer may return or discussed a cost element to the surgery. Those that did gain marks did so for correctly identifying that with surgery there are risks or that removing breast tissue could have implications for the future, such as being unable to breast feed or causing body image issues. Very few candidates appreciated that just because the chances of her developing cancer were high this does not mean that she will definitely develop cancer.

3(c) The vast majority of candidates did not answer this question well, indicating that they had not understood the question or misinterpreted what the question was asking. Few candidates realised that there were other types of cancer or that lifestyle issues could be involved in causing cancer. Most referred to the 'faulty gene' and that she would be unable to remove this gene hence her risk of cancer would always be present.

3(d) Candidates found this question challenging. Most answers contained a discussion about who may or may not have had the faulty allele rather than identifying the line of inheritance from grandmother to mother. Candidates did correctly identify that the father did not have the faulty allele and was therefore not responsible; unfortunately, this did not score a mark. There was clear evidence that candidates could use a family tree, but they seemed to struggle to communicate their thoughts. It was rarely mentioned that the normal allele had only a 0.1% chance of becoming faulty despite the question stem pointing candidates to both the family tree and the information about the allele.

Question 4

4(a)(i) Many candidates did not realise that the figure required to calculate the number of bacteria came from the stem of the question. Common incorrect answers for this question included 100, 1200 and 6000, with the most common incorrect answer being 1600 indicating that some candidates did not complete the last doubling. Unfortunately, many candidates did not show their working so it was not possible to see how they arrived at their wrong answers. Centres should encourage candidates to show their workings as on many mathematical questions this can often score them a mark.

4(a)(ii) Answers for this question were variable and very much depended on the strategy used to calculate (a) (ii). Those that gained numbers in the thousands for (a) (ii) often went on to discuss the idea that to reach 20 000 bacteria would only take hours and not days. Some candidates went further than this and did include calculations to demonstrate how they had arrived at this decision which was good to see. Those that had struggled to double the numbers in (a) (ii) often failed to score on this question.

4(a)(iii) Very few candidates scored marks on this question. Many seemed to misinterpret what the question wanted and rather than stating two ways in which bacteria can cause symptoms of infection the candidates gave examples of symptoms of infections such as swelling, vomit, rash, fever etc. Those candidates that did recognise what that question was asking often went on to score both marks.

4(b)(i) Many candidates gained credit for placing the cross on the correct part of the graph. Centres are asked to encourage candidates to be as accurate as possible with such questions as some candidates narrowly missed out on the mark. Common errors included placing the cross on the line where it met the X axis. Some candidates did not attempt the question - this could be a result of candidates not realising that it was there and so candidates should be reminded to look for the marks at the side of the question paper to ensure they don't miss out a question by accident.

4(b)(ii) This question was answered well by many candidates. It was pleasing to see that candidates clearly had knowledge about the roles of the white blood cells in defending against disease. Many in-depth responses were seen. Weaker candidates lost marks for incorrect terminology such as eating/fighting or attacking bacteria and there was evidence of candidates being confused as to whether the white blood cells produced antibodies or antigens. Some candidates also incorrectly identified the antibodies as engulfing the white blood cells.

Question 5

5(a)(i) The majority of candidates calculated the value of 50 correctly, indicating that they are confident when calculating percentages. Unfortunately, a sizeable number of candidates quoted the value to no decimal places and therefore only scored 1 mark. Centres should reinforce to candidates the importance of reading the question carefully to check whether the number of decimal places required has been stated. Some candidates selected the correct values to use in this calculation, but unfortunately did not formulate them in the correct way.

5(a)(ii) This question proved challenging to many candidates. Candidates often secured a mark for the idea that the figure only applied to Mali, or that other countries were different. However, there was evidence that some candidates had interpreted the question in a number of different ways. Some candidates referred to the fact that the headline only gave percentages, not actual numbers. Others referred to the negative slant of the headline, suggesting there should be positive news about treatment and survival. The final three marking points were less commonly scored. Centres are encouraged to focus on analysing data sets to allow candidates to gain the skills required to answer such questions.

5a(iii) This question was poorly answered in many cases. Many candidates believed that by adding the country name to the headline already given was sufficient to gain the mark. Others rewrote the headline to make it more general to give less information than the original headline for example statements like "Many infected and some died".

The question was quite explicit in asking the students to better represent the data, however few candidates made the link from this statement to the idea that a mean or range would be appropriate approaches to represent the data. The purpose of mean and range in representing or summarising data could be reinforced by Centres.

Where an attempt had been made to calculate a mean there were cases where the percentage calculated exceeded 100% indicating that whilst some candidates are able to calculate percentages they do not necessarily understand them.

5(b)(i) The most common error on this question arose from candidates only ticking one box instead of two, therefore those candidates were unable to gain the mark. Those candidates that did tick two boxes often correctly identified testing ‘animals’ as one of the first stages in testing new drugs. The most common incorrect answer was identifying that testing 'humans with the disease’ was part of these initial testing stages.

5(b)(ii) This was the second of the six-mark extended writing questions. Candidates were asked to consider some information about plans to test a new drug in humans. This question discriminated well between candidates, with marks scored across the 0-6 range. A large proportion scored in Level 2 and it was pleasing to see candidates scoring in Level 3.

The most common correct answers arose from the identification of the use of groups A and B. Many candidates identified that giving healthy volunteers the drug would allow side effects to be identified. Many also identified that giving people with Ebola the drug would allow the scientists to see if the drug actually worked. Many candidates scored in Level 2 for those reasons. It was also common to see candidates discussing the ethical issues of using a placebo with Ebola patients with candidates identifying that the placebo would not help them and as a result they could die. Very few candidates correctly identified the reason for giving group C the placebo. Whilst a number of candidates understood that placebos were a “fake drug”, very few grasped the reasons for using them in drug trials. Centres should ensure that when teaching about placebos and drug trials they highlight the fact that they provide a control group for the other results to be compared against.

Common errors made included giving ethical reasons for groups A and B receiving their corresponding treatments.

Question 6

6(a) It was clear from this question and the response observed that some candidates had a clear understanding of how to interpret data and as a result scored all three marks. Other candidates did not appear to understand how to analyse the information provided and as a result were unable to select the appropriate answers. A full range of marks was observed for this question, with the vast majority of candidates scoring one or more marks. Common errors included the selection of 'neither scientist' for the 'Who describes data' row of the table, which may be a result of students thinking that data had to be in the form of numbers. Centres should ensure candidates are aware that observational and numerical data both count as data. Concept cartoons provide a good method to analyse key features such as descriptions of data and explanations.

6(b) Most candidates scored at least one mark for this question with a high proportion scoring two marks. Statements C and E were often in the correct order, however statements B and D were commonly given in the incorrect order.

6(c) This question was answered well with many candidates correctly identifying the missing word as ‘adapted; a small number used ‘fit’ or ‘suited’ which also gained credit. The most common incorrect words included evolved, used or known.

6(d) This proved a challenging question for many candidates and as a result few candidates scored more than one mark. The question appeared to test candidates' understanding of the interdependencies within food webs well. Some candidates seemed to struggle to interpret the food web and explain the implications of an increase in the deer population on the Neanderthal population, but for many candidates the main issue seemed to be in communicating their ideas.

A good number of candidates had many of the right ideas, but did not use the ideas to form a fully derived conclusion.

The most common correct mark was awarded for identifying that the Neanderthals would increase due to there being more deer for food. A common error made by many was a failure to include any statement about what would happen to the Neanderthal population following a correct discussion of an expected change to one of the other species' population.

Some candidates did correctly identify that an increase in deer would cause a decrease in the vegetable/herb or grass population, but very few candidates then made the link between the reduced vegetable/herbs and the decrease in Neanderthals or that there would be a decrease in bison which would in turn lead to fewer Neanderthals.

Some candidates seemed to misinterpret the question and subsequently went off on a tangent about how the deer population changes over an extended period of time.

Analysing and describing interdependencies is an area of the specification that Centres should address.

6(e) This was the final of the six-mark extended writing questions and was the crossover question with the higher paper. This proved a challenging question in which to gain full marks and as a result fewer candidates were seen to score Level 3.

A significant number of candidates took this question as a follow on from 6d, and tried to use the same arguments to answer this question. Using a food web perspective alone limited their ability to gain marks. Those candidates that approached the question from a more general perspective did better.

The most common correct answers included the identification that Neanderthals had a lack of food or were unable to reproduce. For those candidates who did identify the causes of extinction, the most common answers included environmental change or natural disasters. Many candidates stated reasons such as competition or disease, but failed to identify that the competitor or disease was a new threat. Only a small number of candidates recalled that extinction is linked to an inability to adapt.

Many students wrote that Neanderthals became extinct as a result of modern humans and linked this to road building, loss of habitat, being hunted for their fur or to be used in medicine. This could have been partly avoided if candidates had read the information at the start of the question more carefully. Centres could address these issues through discussion of a wide range of species that have become extinct and the reasons without focusing on the human factors.

Question 7

7(a) Some candidates had clearly learnt the definition of a species and as such gained both marks for this question. Those candidates gaining only one mark often lost a mark for failing to identify that the offspring would be fertile. Many candidates resorted to intuitive notions of a species, such as 'a type of animal/plant', which have 'lots of similarities and are classified together'.

7(b) This question was answered well. The majority of candidates scored one mark for this question through the identification that 'all jellyfish were invertebrates' and that they are not a type of fish or that 'not all animals were vertebrates'. The most common error noted was that candidates thought that the newly discovered animal could be a mammal.

A161/02 – Science A Modules B1, B2, B3 (Higher Tier)

General Comments:

Candidates demonstrated that they had secure knowledge of many aspects of the specification such as appreciating the risks associated with diseases, identifying the sex chromosomes, recognising the cells involved in fertilisation to produce twins and being able to suggest causes and explain why the Neanderthals became extinct. In terms of mathematical skills, candidates were able to successfully to calculate the probability of a patient developing breast cancer.

Candidates did not seem to have the knowledge or skills required to respond to questions about the role of the white blood cells in the immune response, interpreting genetic family tree diagrams, the role of ADH in water regulation in the body and explaining what interdependence is. Other areas of the specification that candidates did not perform well on include analysing and interpreting of graphical data and drawing conclusions from data.

Comments on Individual Questions:

Question 1
1(a) Many candidates were able to provide at least 2 correct responses for 1 mark.

1(b) The majority of candidates were able to produce the correct response.

Question 2
2(a)(i) This was a well answered question. Where candidates did not get the mark, they had not given the answer in the correct format.

2(a)(ii) Candidates who appreciated what a probability of 100 means scored the mark.

2(b) The majority of candidates achieved at least 1 mark for discussion of the risks due to having the operation. Only some candidates were able to discuss further consequences of her decision to have the operation or not.

2(c) This was a challenging question. Candidates had to be able to interpret the genetic family tree diagram correctly to access any marks.

Question 3
3(a) This question was well answered. The majority of candidates knew the process of fertilisation to produce identical twins.

3(b) This was a challenging question as candidates had to be able to describe the stages involved in artificial cloning.

3(c) This question was a good discriminator. Only some candidates were able to discuss how doctors could investigate the impact of the environment on identical twins.

Question 4
4(a)(i) The majority of candidates were able to successfully manipulate the data to work out the number of deaths.

4(a)(ii) Candidates who were able to justify in detail why the headline was not a good summary of the data scored the highest marks.

4(b)(i) The majority of candidates were able to identify at least 3 statements concerning drug trials to score 1 mark.

4(b)(ii) Only some candidates could discuss the long term effectiveness of the drug as well as long term side effects to score full marks.

4(b)(iii) This question tested the full range of abilities. Many candidates produced detailed descriptions of how white blood cells work against a pathogen. Some candidates struggled with this idea in the context of the question, often discussing the concept of vaccinations, which did not gain credit.

Question 5

5(a) This was a challenging question. Candidates found it difficult to link increasing antigen concentration to the reproduction of microorganisms.

5(b) The majority of candidates could identify how long the infection lasted.

5(c) This question was difficult as students had to be able to interpret the graph to describe the relationship.

5(d) This was a challenging question which relied on candidates being able to interpret the 2 lines to identify the correct antibody concentration.

Question 6

6(a) Most candidates could identify that the pituitary glands secrete ADH.

6(b) The best responses could explain in detail the logical sequences of stages involved in the regulation of water.

Question 7

7(a) This question was difficult as candidates needed to give 2 reasons why scientists developed different explanations from looking at the same evidence.

7(b) Candidates who could explain, within the context of the question, a meaning of the term interdependence and use the available food web to give examples scored the highest marks.

7(c) It was encouraging to see very detailed descriptions about the possible causes of extinction of the Neanderthals.

7(d) The majority of candidates could identify the correct responses to complete the evolution sentences.

7(e) This was a well answered question. Candidates displayed good data handling skills in working out the evolutionary relationships.

7(e)(ii) This was a challenging question, with very few candidates explaining the link between DNA similarity and time taken to evolve correctly.

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

General Comments:

Candidates performed well on all aspects of the question paper with the exception of parts of question 5 where candidates were required to give a free response. The clarity of responses was improved, with lines joined clearly and tick boxes clearly identified. Level of response questions were well structured and often gave essential linking of ideas needed to achieve levels 2 and 3.

There were only 2 parts of the paper where candidates were reluctant to respond. These were the calculation of the mean, and to a lesser extent to provide the name of the products of electrolysis. These are areas for improvement in future examinations.

Comments on Individual Questions:

Question 1
1(a) Most Candidates chose the correct answer with no obvious wrong answer consistently selected.

1(b) Generally well answered but 'hydroxide' was frequently chosen incorrectly.

1(c) Few candidates selected both correct answers, however the majority of Candidates could correctly identify 'carbon dioxide' as one of the 2 substances formed when a hydrocarbon burns.

Question 2
2(a) Generally well answered, and done so neatly.

2(b) Many candidates were able to correctly select the relevant data and explain why the petrol car was better. Quoting the data was not enough to score the full marks here and this was the area where candidates appeared to lack the skills needed to access the highest level on a frequent basis. The release of gases into the atmosphere was often confused with burning of the gases. Fewer candidates could articulate the effects of the pollutant gases on the atmosphere. Greenhouse gases and the ozone layer were often confused when used to attempt this question.

Question 3
3(a)(i) This question required the calculation of the changes in 'fossil fuels burned' (millions of tonnes) for at least 2 of the sections of a 10 year period. The command words 'use the data' required such a calculation to enable both marks to be scored. A significant number of candidates didn't attempt the calculation, or incorrectly calculated these values over 2 ten year periods. The final evaluation of the data was generally well done, even when the values were incorrect.

3(a)(ii) Generally well answered from an extrapolation of the graph.

3(b)(i) Most candidates could identify the general upward trend in the data. A significant number could also identify either the fluctuations in the data or the maximum point of the graph.

3(b)(ii) Generally well answered, with 'increased' being identified for the first space and 'correlation' identified for the last space. The only issue was the middle statement. 'Reaction' was a common incorrect response here.

Question 4

4(a) There were many positive aspects to the candidates' responses, and they were able to select the good points in Matt's investigation. However, many did not understand the difference between precision, reliability, accuracy and controlling variables. They tended to use the term "fair test" for explaining every nuance of Matt's testing. Centres would be well-advised to ensure that candidates use the term "control" variable correctly in future. Candidates struggled to link their ideas about controlling variables with positive aspects of the plan. E.g. Matt used the same mass each time. This was a control variable.

4(b)(i) Most candidates could identify the range correctly.

4(b)(ii) Most candidates could identify the outlier correctly.

4(b)(iii) Candidates struggled to give a method to decide if a result was an outlier, instead they offered suggestions as to how they could remove this outlier to have the least impact on the data. This simply didn't answer the question.

4(b)(iv) A significant number of candidates did not attempt this question. Those who did could add the numbers together but failed to divide by 5. Of those that wrote down the correct process, there were several that had clearly not pressed '=' on the calculator before attempting the operation of division.

Question 5

5(a) Candidates could give a property of plastic but it was often not related to the 'bucket'. For example being flexible is not the most important property for this item, but it was regularly quoted. Candidates also gave two properties rather than one property and an explanation.

5(b)(i) Candidates lost marks here because they did not read the rubric of the question. They selected different forms of polymers or used metals as examples. Some candidates gave a use with no material.

5(b)(ii) This was often difficult to score as the previous part of the question had been poorly answered. Candidates often gave just one reason why plastic was better than the material they had suggested.

Question 6

6(a) Few candidates recognised 'chlorine' as the element present in PVC. Nitrogen was a popular incorrect response here.

6(b) Most candidates struggled to identify the correct repeat unit. The most frequently chosen incorrect response was that depicting two and a half repeat units.

6(c)(i) A range of responses here with no real pattern of incorrect choices.

6(c)(ii) Candidates could explain the 'leaching' of the plasticiser from the wrapping into the food and then explain the idea of these plasticisers getting into the body through the consumption of this food.

Question 7
7(a)(i) Most candidates could give the 2 correct values.

7(a)(ii) Although many candidates were able to correctly identify the reasons that the eco-trainers were better, successfully selecting the data to support their explanations, they did not then make the link between sustainability and harm to the environment. This meant a large number of level 2 responses. Unfortunately some candidates didn't 'use the data' from the rubric of the question and so were limited to level 1 by quoting information from the diagram.

Question 8
8(a) Most candidates could identify an advantage and disadvantage of adding salt to food. This showed continuing improvement from previous Examination sessions.

8(b) The candidates struggled to make the connection between the solution mining, the purity of the salt collected and the use in food products.

8(c)(i) Most candidates could identify the role of water in the process and the need for this to be pumped into the ground (as well as pumped out again). Fewer candidates could identify the process of dissolving as one which takes place to produce the brine solution to return to the surface.

8(c)(ii) Only a limited number of candidates could identify any of the products of the electrolysis of brine.

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

General Comments:

This paper was well attempted with a high mean mark. It differentiated effectively allowing strong candidates to show their knowledge and understanding of the subject.

Candidates showed a good understanding of how to measure the properties of materials. They had no problem calculating the best estimate of the true value. They used this, along with the range, to decide if the results could inform the choice of a material for a particular purpose.

There was some lack of clarity to answers, especially in the level of response questions. Candidates should read the question carefully and plan their answers around exactly what they are asked. They should try to be specific in their answers and remember that vague comments such as 'environmentally friendly' or 'harmful chemicals' do not gain marks. They should also give themselves time to read through their answers to these long questions to ensure they make sense and do not contain contradictory comments.

Some candidates ignored requests in questions to 'use data', so did not gain marks. When this request is given they should show the data they have used and explain how they have reached their answer.

The number of no response answers was small, but there were some candidates who had run out of time. They had often spent considerable time writing excessively on the level of response questions. Candidates should be reminded that the space given on the paper indicates the amount of writing needed for a complete answer. Also, this year, there appeared to be more candidates than usual who struggled to respond to the higher level questions. They would have been better suited, and possibly gain a better grade, if they had taken the foundation tier paper.

Comments on Individual Questions:

Question 1
1(a) This was expected to be an easy start to this paper, but few candidates were able to say that burning in oxygen and not air gave a faster reaction or reached a higher temperature. They focused on ideas related to the other gases in air or on complete combustion.

1(b) Most candidates remembered the definition of a hydrocarbon and answered this correctly.

1(c) Balancing the reaction was well done, though a number of candidates lost marks because of poor drawing. Representations of molecules of water and carbon dioxide were given so there is no excuse for repeating these diagrams without touching atoms.

Question 2
2(a) Generally well answered though a third only scored 1 mark. There was no pattern for incorrect answers.

2(b) This question discriminated well. More knew the oxidation step than the reduction step. A common wrong answer for the reduction stage was to say that nitrogen monoxide was reduced to nitrogen **and** oxygen.

2(c) This first level of response question was answered well with good differentiation between the levels. Most used the data to achieve level 1. Some were vague about the effects of the pollutants, repeating ideas of fatal, harmful and polluting. More failed to comment on banning from cities or just wrote they were banned because of pollution or harmful gases which did not gain marks. Another common problem was that candidates were uncertain about the difference between using something and producing something. It was not uncommon to read that petrol cars use more carbon monoxide than diesel cars.

Question 3

3(a) In part (i) candidates were able to extrapolate a graph and give the correct result. Part (ii) asked about the difficulty in extrapolating further. Most gained marks by stating that fossil fuels were a finite resource and other sources of renewable energy would be used. Few marks were awarded for population increase, nuclear energy and more efficient power stations.

3(b) Many gained 1 mark by describing an increase in both graphs, but few seemed able to describe the correlation shown by these graphs. They should be encouraged to think about what happens in the second graph as the first one changes; i.e. as fuel burned increases, what happens to the increase in global temperature? Some were confused between correlation and cause.

Question 4

4(a) This question was an overlap question with the foundation paper and there were very good discussions of the features of the experiment for a level 2, with many accessing level 3 by giving detailed reasons for the differences and merits of the three plans. However, weaker candidates were often vague when linking reasons to features. It was not uncommon to find a list of features followed by the sentence 'making it fair and accurate'.

4(b) Parts (i) and (iii) of this question were done well. Candidates have no problem spotting outliers and calculating the best estimate of the true value. More difficult was explaining whether to include or discard outliers in the calculation. A common wrong answer was to calculate the mean, with and without the outlier, and see if there was a difference: candidates were unaware that it is important to make a decision about the outlier **before** the mean is calculated. Part (iv) of this question discriminated well. Some weaker candidates failed to gain marks because they did not use the data. Others wrote about the best estimate or the range, but not both. Some of those discussing the range believed, incorrectly, the difference was because one range was narrower than the other.

Question 5

5 This was another discriminating question. Most could link molecular size to boiling range, but only better candidates were able to describe the role of intermolecular forces in the boiling ranges. Confusion over intermolecular forces and bonds was common with candidates believing that bonds in the molecules broke when liquids boiled. Some had learned about fractional distillation and wrote about this instead of answering the question. And there are still some candidates who confuse boiling and burning.

Question 6

6(a) A large percentage did not name the atom correctly in part (i). All sorts of answers were given ranging from chloride to atoms such as helium, silicon or argon. More were able to draw the monomer of PVC having been shown part of the molecule in part (ii). Correct diagrams here were generally drawn well.

6(b) In part (i) few could explain logically why adding plasticizers makes PVC more flexible. Only half the candidates scored any marks, with very few gaining the full three. There were many mixed up ideas about polymer modifications. Some confused adding plasticizers with breaking crosslinks and others suggested adding plasticizers affected the crystallinity of the PVC. The main problem with answers to part (ii), was that candidates thought PVC was harmful and did not realise it was the plasticizers that leached into food which may cause harm when eaten.

Question 7

7 There was plenty to write about in this question, but unfortunately, very few reached level 3. Far too much effort went into restating data from the question paper without analysing it or using the prompts in the question to structure their answer. Reasons such as plants being carbon neutral were rare, as was the use of the word 'resources.' Some did discuss the total energy and greenhouse gases, but then spoiled their argument by saying the disposal figures were the same. This level was usually given to those giving figures that totalled those in the table. The additional information points were mainly scored by how long they lasted or the impact of their use. A few mentioned water, but no-one discussed the impact of growing crops for materials rather than food.

Question 8

8(a) In part (i) most got B at the beginning and many C at the end, but the mark for AG in the middle proved more difficult. This type of 3 mark question is often attempted too quickly, without thinking through the whole process. Part (ii) was well known by almost all.

8(b) Part (i) was a discriminating question with able candidates scoring both marks for the products of electrolysis. Part (ii) proved difficult for many. In this and in part (iii) there seemed little understanding of the link between chlorine made, the electricity used to make 1 tonne and the total electricity used. Candidates were much more likely to extrapolate and interpolate along the rows to reach the wrong answers. Also, because of this lack of understanding of the data on electricity used, many only gained marks in part (iii) for an increase in chlorine production and a decrease in toxic products.

A181/01 – Science A Modules P1, P2, P3 (Foundation Tier)

General Comments:

Candidates worked hard on this paper, and had prepared beforehand. We saw fewer questions with no response, and fewer candidates writing comments that did not address the question. The foundation tier was also appropriate for almost all those entered, who clearly found the higher demand questions, Q.4., Q.5., and part of Q13, very challenging. The poor performance on these questions may have indicated that C and D grade candidates were being entered for the higher tier.

Those candidates with a calculator usually used it successfully, both to score marks and save time. Some candidates did not use, and possibly did not have, a calculator.

For some questions large numbers of answers showed no working. It is always with regret that examiners give zero marks when they know that, had the candidate written the first line of their calculation, a mark could have been awarded.

For the calculations, many candidates were unsure whether they should divide or multiply. They wrote out, and did, both calculations correctly, and then chose which answer to write in the answer space. It is possible that at this point they used reasoning to decide whether their answer should be smaller or larger, but it is equally possible that they guessed. No marks could be awarded for the incorrect answer, as they had not made use of their correct working. Candidates like these have good calculation skills but need to improve their reasoning.

For questions that asked for an explanation, candidates often gave a second example, so did not score full marks. The command words used in questions are very specific, and candidates should be encouraged to take these into account. Only a very few highlighted command words to help them focus. They are very good at realising that 2 marks requires a 2 part answer, but need to realise that two suggestions will only score 1 mark for, ‘suggest and explain.’

Answers to extended writing questions continue to improve, and some candidates are good at writing reasoned arguments. There is, however, a significant minority of candidates who cannot access these questions, and, although we are seeing fewer with no response, we see responses that are not worthy of credit. In some cases these show that the candidate does not understand the question at all.

Comments on Individual Questions:

Question 1
1 This was very well answered. The crust was almost always known. A few of the weaker candidates thought the core was the nucleus.

Question 2
2 Most candidates scored at least one mark here, many scored two. The common errors were to choose the number of stars in galaxies, or the number of galaxies in the Universe, as a reason.

Question 3
3 Candidates thought hard about this, as shown by the changes they made as they worked out the answers. The majority scored one and many scored two marks.

Question 4
4(a)(i) At least half of the candidates did not show their calculation. There were lots of answers of 1250 km/s and evidence of candidates changing their mind between 8 km/s and 1250 km/s. Answer = 8 km/s

4(a)(ii) Few candidates could do this part and few showed their calculation. Some used a time of 12.5s and scored 1 mark for the speed calculation.
Answer = 4 km/s

4(b)(i) Understandably, since this question was targeted at grade C, very few understood the question and there were lots of descriptions of P and S waves in solids and liquids. Many thought that, 'you can't tell'. Some candidates had difficulty communicating their answer and repeated the question.

4(b)(ii) It was common to see the cross on a line between A and B – anywhere along the line, but more often 100 km from B.

Question 5
5 Those candidates who remembered something about how sedimentary rocks are formed gave a reasonable, but brief, answer to this part of the question. Some thought that sedimentary rocks are made of dead plants and animals, or of fossils. Weaker candidates often just described a feature of the diagram. Few candidates understood, or were able to explain that features of the diagram, such as many layers or distorted layers, took a long time to form. It was more common to see the suggestion that it happened a long time ago, rather than over a long period of time, and weaker candidates often did not mention the time at all.

Question 6
6 'Electromagnetic' was most commonly correct, followed by 'photons'. The colour was more difficult. Blue was very common, and some answers were not a colour.

Question 7
7(a) The fact that X-rays can cause cancer was recalled by many candidates. However, answers about sunburn showed that many cannot distinguish between ultraviolet radiation and X-rays. Some of those who wrote 'skin cancer' were probably confusing the radiation ranges rather than showing knowledge of the risk to radiation workers.

7(b) There were good answers suggesting a barrier, or an example of a barrier, that would protect from X-rays, but also a small but significant number of unsuitable suggestions, such as face-masks, lab-coats and gloves. Some candidates had the impression that glasses or goggles were all that was needed. Explanations were not often given, so it was rare for a second mark to be scored.

7(c) Correct answers commonly described gamma rays as having higher power or frequency, being more ionising and, sometimes, being more penetrating. There are impressions that gamma rays are 'more radioactive' and 'stronger' than x-rays. There were some good answers stating higher energy photons, higher frequency, more ionising – although some candidates did not score for 'highest' or 'top' of the electromagnetic spectrum. They may have had more experience with comparing an ionising with a non-ionising radiation, as some candidates failed to score marks with answers, such as 'gamma rays are ionising' and 'gamma rays have a high frequency'.

Question 8
8(a) Many candidates answered this correctly. Candidates do know about mobile phones and camera resolution. Some students did not show their working. A common mistake was to key 2.4+2.2+2.0÷3 giving 5.27. Others forgot to divide by 3 and left the answer as 6.6.
Answer = 2.2 MB

8(b) This was very well answered, but there were some candidates who multiplied rather than divided.
Answer = 200

8(c) Again, very well answered. The most common error was to select the suggestion that the images could be stored on a computer.

Question 9
9 For the first part of the question many candidates offered the information that the Sun's radiation contained ultraviolet, some said that it contained more energy. Some candidates have the overall idea of the greenhouse effect – that this is an effect which traps some radiation, or heat – others can tell you that carbon dioxide is a greenhouse gas and that the Earth is warming up and there is some connection between the two – but they do not appear to have any idea what the connection is. Although this question was targeted at lower ability candidates, it was clear that this is an idea that is very poorly understood below C grade. A lot of candidates thought that the greenhouse gases were trapped in the atmosphere and could not escape. Some said that the Earth's radiation was carbon dioxide, or pollution, and some went on to say this was trapped by the ozone layer.

Question 10
10(a) Most candidates knew that water turns into steam, but turbines and generators were confused, and other suggestions such as fans, motors and 'wind' were suggested, for 'generator' and for 'magnet.' Reading the question more carefully might have helped students who suggested 'coal' or 'heat' instead of water.

10(b) The majority of candidates knew that the efficiency was 38%. Weaker candidates thought it was 62%.

Question 11
11(a) All 3 incorrect answers were seen, although the sum was less popular than the two meter readings.

11(b) This question illustrated the problem candidates have in deciding whether to multiply or divide. Less than half of candidates ticked to say they would calculate the cost of the energy used by multiplying the number of kWh transferred x the cost of 1 kWh. The option of dividing the energy used by the cost of a unit was preferred over dividing the cost of a unit by the energy used.

11(c) This question was done well, with the majority scoring at least one mark and many scoring two marks. A common error was to choose that the cost of a kWh was less in March.

Question 12
12 We saw very encouraging responses that suggest many GCSE students understand the actions required to reduce global warming and improve the environment. Those candidates who addressed Brian's comments made some very good points. A few candidates expanded on these with extra detail. There were some good answers that covered alternative transport and candidates could suggest many improvements. As well as those points specifically mentioned on the mark scheme, which were often seen, candidates suggested car sharing, hybrid cars, and driving more slowly. Some explained that a bus uses more fuel than one car and saves energy by replacing many cars. Similarly, with insulation, candidates explained how badly insulated

buildings resulted in heat loss and suggested many ways of reducing the energy waste. Alternative sources of power were often suggested. Students lost marks most often by not covering both parts of the question. Some candidates did not focus on Brian's comments but talked instead about leaving lights on, and turning them off, or not wasting energy. They were given some credit for these answers.

Question 13

13(a) This was very well done. A very small number of candidates divided rather than multiplied.
Answer 575 W

13(b) Wrong calculations were common. Very few candidates converted minutes to seconds, the answer 3000 J was very often seen.
Answer 180 000 J

13(c) Most candidates stated that the number would be larger, and explained that this would make it difficult to read or understand. A few thought that the bills would look more expensive or even that it would be more expensive. There were some incorrect answers stating that kilowatt hours are smaller or the energy is less in kilowatt hours.

A181/02 – Science A Modules P1, P2, P3 (Higher Tier)

General Comments:

Few candidates seemed to have been short of time, and examiners commented that the majority tackled the questions well in extended writing and that the mathematical aspects were done better this year than in 2015. Answers were generally clearly and logically presented but there were a number which were very difficult to decipher – some almost completely illegible – and may well have lost marks from this.

As last year, a number of low-scoring candidates were clearly entered for this paper when they would have been much more successful in the foundation tier, and their papers were characterised by many questions being left unattempted. Candidates entered for the wrong paper in this way are being done a serious disservice by their Centres.

Examiners frequently reported on two aspects of candidates' performance which need to be brought to the attention of Centres.

(i) Organisation of longer responses. The extended-response six-mark questions need clear organisation and expression. In these questions it is important that candidates read the question carefully; in question 11 many failed to address the consequences of population change and movement in the stem of the question.

(ii) Mathematical skills. This year, the organisation of calculations was generally better than last year, although weaker candidates often showed no working and could not cope with unit changes from W to kW, for example. In laying out their work, many candidates (including very good ones) use the '=' sign to mean a range of things, from its real meaning to 'and from this we can see that' or 'which leads me to think that what I need is'. Question 3 focussed on inverse proportion, which is a difficult mathematical skill that is required in the specification; only the better candidates were able to deal with it successfully.

Comments on Individual Questions:

Question 1
This extended response 6-mark question was common with the Foundation tier paper, and over 50% of the candidates achieved a level 3 mark. Weaker answers showed confusion between sedimentary and igneous rocks, with many candidates very keen to write about sea-floor spreading.

Question 2
Most candidates could calculate the speed of the P-waves in part **(a)(i)** while about half could do the two-step calculation to find the speed of the S-waves in part **(a)(ii)**. In **(b)(i)**, most could state why the earthquake epicentre must have been on the circle but only the best realised that the lack of any direction information meant that the precise location could not be known. In **(b)(ii)** a surprising number of candidates who had already explained why the earthquake position had to be somewhere on the circle then suggested a location which was not on the circle at all.

Question 3
In part **(a)**, about one candidate in four realised that the angle of 0.74 seconds of arc was very tiny, and very, very few were able to explain that a scale diagram would require a piece of paper which was extremely long in the horizontal direction or else the tiny angle would result in the size of the Earth's orbit shrinking to a dot. It was clear that the meaning of 'scale diagram' was ill understood.

Part **(b)** was testing the mathematical skill of inverse proportion, which is required by the specification but is always a difficult one for candidates. Few realised that in **(b)(i)** all that was required was to spot that halving the angle would double the distance and of those, about half were then able to apply this to the mathematically more complex situation of Gliese 667, where the multiply/divide factor is 5. All possible numbers in the question were used in attempted calculations, including the 667 of the star's name.

In part **(c)** most candidates spotted that Gliese 667 is very far away from us, and that travelling there is not feasible, but few used the fact that all the information we have about distant stars and galaxies comes from the radiation they emit, and that seeing light reflected off a planet orbiting around Gliese 667 is difficult to achieve.

Question 4
This objective question was generally well answered with most candidates scoring more highly on part **(b)** which tested understanding of Ideas about Science.

Question 5
This was the most difficult of the extended-response questions in the paper. Most candidates could explain why the intensity of light falls off with distance, either in terms of photons or in terms of a general wave model, and stronger candidates were able to rearrange the given equation to calculate the required lamp power. A number of candidates read 'suggest why planning regulations require a minimum light intensity' as meaning 'suggest why planning regulations required the light intensity to be as small as possible': credit was given for this misinterpretation.

Question 6
Roughly half of the candidates identified the two correct statements in part **(a)** while the short free-response part **(b)** discriminated well between candidates, with the best responses clearly referring to ionisation, electron removal and changes to molecules in the cell.

Question 7
This objective question was quite demanding with most candidates making one, two or three errors in identifying the properties of digital and analogue signals.

Question 8
Parts **(a)** and **(b)** were also on the foundation tier paper, and candidates on this paper scored highly on them, although some omitted to convert minutes into seconds in **(b)**. Part **(c)**, involving two unit conversions, proved more demanding for all except the best candidates.

Question 9
This was an objective question testing the ability to read and manipulate the data in the given table in part **(a)** and to identify the appropriate Sankey diagrams in part **(b)**; accordingly, part **(b)** was the more straightforward and was completely correctly answered by about half of all candidates.

Question 10
Both the objective part **(a)** and the continuous prose of part **(b)** tested candidates' understanding of the difference between these terms. Part **(b)** revealed the confusion of candidates more clearly: radiation is thought of as a substance rather than a transfer of energy via tiny particles or photons, and so contamination is not so clearly distinct from irradiation as it is to physics teachers and examiners. Many responses to this question seem to suggest that irradiation is less harmful than contamination in the same way that alpha particles are less penetrating than gamma radiation. The understanding that irradiation is transient, occurring only while in the vicinity of the source, is often absent.

Question 11

This extended response 6-mark question was well answered by most, but level 3 responses require use of all the information given: not only the ideas of sustainability and environmental impact of different power stations (which was very well tackled by almost all candidates) but also the fact that developing countries have increasing populations with increasing urbanisation which was in the stem of the question.

A144 – Science A Controlled Assessment

General Comments:

In this session, it was pleasing to see how many Centres administered, implemented and assessed the Controlled Assessment unit. Many had focused on areas for improvement from last year's reports. A minority had, however, become a little complacent, while some others had neglected areas that had been done well previously.

Overall, Centres are to be commended for their uploading or dispatch of marks, many of which were actually well before the 15th May deadline, and the subsequent turnaround of samples. A minority, however, had clearly dispatched samples after half-term despite having received requests for samples in good time.

A significant number of arithmetical errors and clerical errors was once again noted, however, which is a little disappointing, as only nine marks need totalling.

Still lacking from many Centres are detailed accounts of how the tasks and levels of control were administered, and documentary evidence of internal standardisation techniques. Much of the inconsistent marking seen suggested that this was attributable to a lack of, or scant internal standardisation procedures in some Centres. 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.' Page 114 of the specification suggests some ways in which this can be carried out.

In some instances, there was clearly some confusion as to guidance and collaboration permissible in phases of limited and high control. As a general rule, research and the collection of data are under limited control; candidates' write-ups, i.e. their analysis, evaluation and review of collected information, are under high. The implications of these issues are discussed further in the respective sections of the report.

It was clear that many Centres had addressed concerns in last summer's Principal Moderator's Report to Centres or from their Centre Report. The application of marking criteria was good across many Centres, but it is also clear that many have misinterpreted the marking criteria or, importantly, have not applied these in a hierarchical manner, with the requirements of one mark band being fulfilled before moving on to the next. Centres are also reminded, when developing skills, to incorporate Ideas about Science (pages 130-138 of the specification) into teaching schemes, and pay due consideration to requirements of Grade Descriptions (page 96-97 of the specification) and Quality of Written Communication (page 97).

Annotation of candidates' work was excellent in many instances, but variable from Centre to Centre, and sometimes within a Centre. It should be noted that 'each piece of internally assessed work should show how the marks have been awarded in relation to the marking criteria'. It is also an important 'means of communication between teachers during internal standardisation'.

On a presentation note, Centres should also take particular note of the submission of candidates' scripts. It would greatly assist the moderation process if these were presented in cardboard wallets or cut-flush folders, or bound with treasury tags; please do not enclose this material in plastic wallets. That said, fewer of these were seen this year. A small number of Centres submitted work that was very disorganised indeed, and Candidate Numbers and Names and even Centre Numbers were sometimes omitted. It is not a constructive use of a moderator's time to have to look up Candidate Numbers.

Comments on the two elements:

The Case Study

Centres are reminded that it is essential that candidates should carry out the task corresponding to the year of submission indicated on the front page of the News Sheet and on the Information for Teachers documents. There were, however, very few instances of inappropriate submissions this year.

The choice of three topics for the Case Study for 2016 was:

Extinction or survival?

Using chlorine to treat water

Ultraviolet radiation

The evidence suggests that 'Extinction or survival?' and 'Ultraviolet radiation' were, more or less, equally popular with Centres. Candidates at slightly fewer Centres, though still a significant number, attempted the 'Using chlorine to treat water' task. The Extinction or survival? Case Study generated scripts with the science of most variable quality, though many excellent scripts were seen.

The 'News Sheet' provides candidates with a starting point for their study, and please note that its presentation to them is under limited control. On the basis of discussion, candidates choose a question for investigation based on the material provided. Candidates should be encouraged to state clearly their question for research at the beginning of their reports, which would help to focus their response. In this session, problems arose where:

- the title quoted for investigation did not truly represent a question
- the content of reports sometimes seemed to move from one question to another, or did not represent the title of the study
- candidates had chosen areas of the topic that did not lend themselves to gathering information to represent opposing viewpoints, or represent opposing arguments to a similar extent or level, or where scientific evidence was limited.

A little more discussion during this limited control phase would have led to fewer inappropriate questions; Centres are advised that 'candidates should be encouraged to develop their own titles to study, *in consultation with the teacher*' (Science A: Guide to Controlled Assessment, page 11). That said, there were instances where evidence suggested that teacher guidance may have stifled candidates' individuality; the two are not mutually exclusive.

Comments on individual strands:

Strand A: Finding sources of information

A(a) – Planning and research to collect information/data

In this Aspect of Performance, it was pleasing to see most candidates having supplemented information from the News Sheet with additional references. Many candidates had sought information sources that clearly represented opposing views. Centre marking was largely accurate, though assessors should be careful in their award of four marks; information must be selected from information sources that provide a *balanced* coverage of a range of views. Clearly, this criterion cannot be awarded if a limited set of information sources is used or the information sources representing one side of the argument are of questionable quality.

A(b) – Acknowledgement and evaluation of sources

Many candidates demonstrated good practice in referring to information sources used. Those working at higher levels should be compiling these in a references list as well as referring to them or citing them in-text. An acknowledged system, such as the Harvard System or Vancouver System should be used (the latter, numerical system, is recommended at this level owing to its ease of use). Candidates were generally very good in identifying quotes.

To obtain full marks, referencing should be fully detailed. For Internet sources, as well as books, authors, titles or articles and dates of publication or access should be cited (where these are given), as well as full URLs. Book references were rarely fully-detailed, although in most instances, there was sufficient information to lead the moderator to the source material.

References lists can be produced under limited control and taken into the high control phase, to obviate problems with replicating website URLs accurately, and also to reduce high control time devoted to this. It is almost certain, of course, that the sequence of these will need to be changed as the report is compiled.

For 3-4 marks, candidates should attempt to give some comments on the validity of the information sources found/collected. These may be in the form of an addition to the reference, in a table, or in the text. While many Centres were justified in their award of three marks, some candidates were awarded four marks where evaluative comments were limited and/or replicated from one information source to the next, or even absent. A document to help to develop candidates' skills in evaluating information sources is provided as Appendix I. Note that this has been updated since the 2014 report.

There were many instances where either the detail in references or the quality of evaluative comments precluded the award of the full four marks, but nevertheless, these had been awarded.

Strand B: Science explanations

Candidates are expected to use scientific knowledge and explanations in two areas. Ideally, they should begin the report by describing and explaining the background science to the topic area, so as to put the question into context, i.e.

- **Extinction or survival?:** extinction; causes of extinction; rate of extinction; the influence of humans on extinction; biodiversity; conservation; reintroductions of species; genetic variation; gene pools; adaptation to environment; development of medicines from organisms.
- **Using chlorine to treat water:** chlorine chemistry; mode of action in killing microorganisms; contribution of chlorination to public health; cholera and typhoid; disinfection by-products (DBPs), trihalomethanes; carcinogenic and teratogenic effects resulting from chlorination; cancer; alternatives – ozone, ultraviolet radiation and BCDMH.
- **Ultraviolet radiation:** ultraviolet radiation and the electromagnetic spectrum; ionising radiation; damage to living cells; ageing of the skin; skin cancer; ozone layer and ultraviolet radiation; sunscreens; ultraviolet radiation and vitamin D synthesis; other physiological effects of ultraviolet radiation; ecological effects of ultraviolet radiation; applications of ultraviolet radiation.

This introductory science used by candidates was often comprehensive, but varied considerably from Centre to Centre. Problems arose where candidates did not fully appreciate what was to be included in this section, or perhaps omitted it altogether. The omission of any background science led to significant discrepancies between Moderator and Centre marks. In its absence, Centres should note that the highest mark that can be given to candidates is five. A common problem was the lack of consistency of the quality of science in the respective sections.

It is suggested that diagrams should be used to support the communication of these concepts; in general, these were rather limited or replicated directly from the source material without much comment or elaboration (and often redrawn, which is not an effective use of time). A good deal of erroneous or over-simplified science was also seen in these introductory sections.

Scientific knowledge and understanding should further be illustrated in candidates' review of the evidence for and against their questions. Discussions often lacked precision, though many candidates working at higher levels analysed data supporting opposing sides of the argument. In particular, the discussion in the Extinction or survival Case Study was often rather generic in nature, when data pertaining to the questions was often readily available.

Candidates could well refer more often to the scientists or bodies carrying out the research that produced the evidence to improve the quality of their studies. In many instances, there was little evidence of the clear application of Ideas about Science.

In this strand, Centres sometimes over-estimated the level of science used, and hence were over-generous with the award of marks. In the 7-8 mark band, candidates are expected to analyse and interpret information presented on respective sides of the argument, which will necessarily involve the use of numerical data. There were many instances where candidates produced excellent discussions but did not support these with numerical evidence.

The quality of written communication used by candidates is assessed in this strand. This often worked to the benefit of candidates, with the quality of spelling, punctuation and grammar helping to support Centre marking where the mark given for science was rather less secure.

Strand C: Conclusions and recommendations

In Strand C, marks would be expected to be the lowest of the strands, though this was not always reflected in Centre judgements.

C(a) – Comparing opposing views and evidence

In this Aspect of Performance, candidates are expected to organise the information they have collected to present opposing arguments. Most candidates chose to present this in clearly identified, separate sections, then make comparisons in an additional section or table (comparisons in tables were often good, though organisation of information was sometimes inaccurate or indiscriminate, so no true comparison was offered). While marks awarded by Centres at the 3-4 mark level were generally secure, marks in 5-6 mark band were often not, and some Centres were over-generous with marking. At this mark band, comparisons must not only be detailed, but also truly compare opposing points addressing the same parameter. Candidates working at higher levels often presented a sequence of opposing arguments showing a clear evolution of pertinent points. Commendably, these were often linked with 'connectives', and a document is attached, as Appendix II, to assist further in the development of these skills. There were many instances where Centres gave six marks to candidates where no discernible comparison of science was made. It was often possible to support a mark of five when candidates had organised information effectively.

In the 7-8 mark band, candidates are expected to review critically the evidence presented supporting the respective sides, evaluating its validity, and making decisions as to which information sources to use for drawing the conclusion in Aspect C**(b)**, e.g. I am going to draw my conclusion from Source A (rather than Source B) because... Centres rarely appreciated the level of the critical comparison required here. As a consequence, marks in the uppermost mark band were less often supported. As with Aspect of Performance A**(b)**, the Centres' attention is drawn to Appendix I, and also Ideas about Science.

In common with the 2015 session, a surprising number of candidates seemed to attempt to by-pass the 5-6 mark criterion by evaluating the *information sources* used but not comparing the *science* in the respective arguments.

C(b) – Conclusions and recommendations

In this Aspect of Performance, candidates should draw on selected information sources to draw a conclusion. At the 3-4 mark level, the conclusion should be based 'on the extent to which the views or opinions are supported by scientific evidence'. The marking criterion, at the 5-6 mark level, states that the conclusion must be 'clearly linked to evidence in the report'. It was commendable in this session, that many candidates produced excellent, lengthy discussions leading to well-reasoned conclusions. Recommendations that followed, however, were sometimes markedly shorter and often vague, somewhat generic, or even absent. For six marks, Centres should note that the marking criterion refers to recommendations, plural. It should be emphasised to candidates that these recommendations should be spelt out. Some candidates did little more than allude to them.

Some questions posed did not always lend themselves to recommendations, or often conclusions and recommendations could not be distinguished owing to the nature of the question. Occasionally, the body of the report along with its conclusions and recommendations did not quite match the question, but benefit of doubt was given here, where possible. As already stated, it was often disappointing to see sub-standard recommendations when conclusions had often been so thorough, and the difference in quality was not always picked up by Centres when awarding marks.

In the 7-8 mark band, candidates working at higher levels often discussed alternative recommendations and limitations to the conclusion, but different interpretations of the evidence were more rarely seen. These aspects were often a focus of candidates' attention, while not having provided recommendations at the 5-6 mark band. Owing to the hierarchical nature of the marking criteria, top mark band marks could not be supported. Overall, candidates struggled to accrue marks at this level.

Practical Data Analysis

Centres are reminded that it is essential that candidates should carry out the task corresponding with the year of submission indicated on the front page of the Information for Candidates and Information for Teachers documents. There were, however, very few instances of inappropriate submissions this year.

The Practical Data Analysis task requires candidates, based on the hypothesis provided, to design, carry out, interpret, evaluate and review an investigative practical experiment in which they have collected primary data. The tasks provide a foundation for progression to the full-scale individual investigations in Additional Science A, and Separate Sciences.

OCR provided a choice of three topic areas that have generated hypotheses to be tested by candidates.

For 2016, these were:

How do different plant species affect each other?

The hypothesis:

The growth of plants is affected by their distance away from a tree or hedge.

Salt mining

The hypothesis:

Temperature of water affects the time taken for the salt to dissolve.

Solar panels

The hypothesis:

The voltage output of a solar panel depends on the area of the panel exposed to the light.

The Controlled Assessment rules state that tasks can be 'contextualised', which means that Centres can adapt them slightly to fit with local conditions (including the types and amounts of equipment available, lab space, and safety considerations). They should not, however, be modified.

In a small number of Centres, in the Salt mining task, candidates measured the *amount* of salt that dissolved at different temperatures, and not the time a specific mass of salt took to dissolve. The OCR hypothesis was not therefore tested. Clearly, this affected the award of marks in

Strand G, and in Strand D, but here, only at the 7-8 mark level. Other strands were moderated against the marking criteria in spite of the correct hypothesis not having been tested.

Candidates in many Centres derived a prediction from the hypothesis provided; although this can be credited in the lower mark bands of Strand G, there is no actual requirement to do this and it sometimes created confusion in the review strand.

There were some instances where the number of values of the independent variable to be tested was limited to four or even three. Five is the generally accepted number to collect sufficient data to demonstrate a trend.

Following the discussion on presentation of the Practical Data Analysis to candidates, they will have a good idea of how to carry out the task in outline, but opportunities must be provided for candidates to decide for themselves how many of a range to test, or the range itself, how many repeats to do, and which chemicals/materials/equipment to use. Higher-scoring candidates must be able to justify these selections at a level commensurate with grade A/A* students.

The Salt mining task was marginally the most popular task, with many Centres opting to investigate solar panels. The quality of science discussed tended to be a little higher for the latter task. A very limited number of Centres indeed chose to do the 'How do different plant species affect each other?' task.

Comments on individual strands

Strand D: Choice of methods, techniques and equipment

Many very sound methods were seen, but Strand D was quite often generously marked. In this strand, candidates are expected to write a method suitable for testing the hypothesis. They often discussed variables, sometimes to very good effect. This should not detract from the method itself, however. Many candidates often produced lengthy discussions of equipment used and variables, but neglected to present a coherent method.

Candidates failing to mention the use of repeats can be given marks at the 3-4 mark level, provided there is evidence of these in results' tables. In order to secure marks in the 5-6 mark band, repeats *must* be described in the method (and the method used must be appropriate to generate data 'of generally good quality'). In the Salt mining task, candidates often suggested, mistakenly, that carrying out the experiment at another temperature was a repeat. As already stated, candidates must ensure that there are a sufficient number of measurements made across the range of the dependent variable to make their testing of the hypothesis valid; candidates in some Centres had only three or four data points to plot. A common oversight was failing to specify the measurements to be made. On occasion, candidates had alluded to these without providing detail, so moderators could go some way in supporting Centre judgements. In other instances however, Centre marks were significantly lowered.

Candidates across the mark range attempted to justify equipment used, but often, these did not amount to true justifications. Good scientific justifications of the method, range of values, equipment and techniques selected must be provided for candidates to be awarded marks in the 7-8 mark band. 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. Please note that if referred to, results of this should be presented. While desirable, this preliminary work should, in many instances, be carried out with some caution. It was clear that many candidates did not understand why they were doing these experiments, and they served only to confuse,

Justifications provided by candidates were often weak, and the reasons for the use of a specific method, in particular, were often not provided. Many candidates produced tables, ostensibly to justify the equipment used, but these often listed every piece and included some very mundane statements. In this mark band, candidates should be using terminology such as 'resolution', 'accuracy' and 'precision' in their justifications. At this level, the use of repeats can be justified. It should be emphasised to candidates that the way in which the criteria are accrued is

hierarchical, so they would do better in focusing their efforts in ensuring that responses to the lower marking criteria are in place and adequate. It was commonplace for Centres to have marked work at 7-8, to be brought down to six at moderation.

In this strand, candidates are also required to review aspects of Health and Safety, ranging from basic 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, as a minimum:

- the chemical, organism, piece of equipment or activity that is likely to constitute a hazard
- the hazard defined (using the appropriate terminology, e.g. irritant)
- the associated risk(s)
- measures intended to reduce risk.

Candidates could go on to consider emergency procedures.

Candidates in some Centres attempted to quantify risk, and while very commendable, this exercise is very difficult indeed to undertake meaningfully at this level.

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). In the Practical Data Analysis, in contrast to the Practical Investigation, it is not a requirement for information sources to be referenced for a Risk Assessment to be 'full'.

There was often a mismatch between the quality of the method and the Risk Assessment, and Centres are reminded that if a Risk Assessment, or any comment about safe working is missing, the highest mark possible is *one*.

Main points *specific* to each task:

How do different plant species affect each other?:

- good hygiene practice when carrying out fieldwork and handling any plants
- the transect line and tripping
- hazards and risks associated with specific plants, e.g. stinging for stinging nettles; thorns for bramble; allergens

Quadrats should have been placed along the belt, so any references to throwing were not pertinent.

Salt mining:

- hot objects, such as the beaker
- scalding water, though this must be related to the maximum temperature investigated
- sodium chloride, or other salt used, must be included, though designated as low hazard/minimal risk, cf. salt water at 3.5%
- liquid in the thermometer.

Solar panels:

- hazards and risks from a hot lamp
- not looking directly at the light source; this *could* be the Sun
- PAT of any mains appliances used.

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 were omitted.

For 7-8 marks, for a Risk Assessment to be 'full', it must refer to *all* potential hazards and risks. Here, candidates should be encouraged to use statements such as 'low hazard' and 'limited risk', if appropriate. Candidates should also consider hazards and risks of a final product of the experiment, e.g. an incubated agar plate, or, though not applicable in this session's tasks, the products of a chemical reaction. Many candidates did not include hazards/risks associated with the use of sodium chloride, albeit limited/low. For a Risk Assessment to be 'appropriate', the hazard/risk must be commensurate with that for the chemical/equipment/activity used or undertaken. A good illustration of this would be when referring to different concentrations of acids, where the hazard would vary from 'corrosive' to 'harmful/irritant' to 'low hazard'.

Strand E: Revealing patterns in data

Some Centres need to take note on how marks are awarded in this strand. Candidates should follow one of two routes, for either graphical or mathematical/statistical analysis of data (though the 'dividing line' could be crossed once, for instance, by the candidate producing a good graph on the upper row, then calculating a gradient and using this to reveal patterns in data on the lower row), and the higher mark achieved across the two rows carried forward to the unit total. A small number of Centres, once again, averaged the two marks or even added these to produce an inappropriate final mark.

It was pleasing to see that most of the quality of graph work was much improved from 2015, though this improvement was not consistent across all Centres' submissions. 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, and some graphs were of surprisingly poor quality.

Scales used by candidates were sometimes problematic. If a scale is inappropriate, e.g. where these were non-linear, or without one or more labelled axes, the candidate mark cannot exceed four or five marks. Please note that axes do not have to start at 0,0; and the inclusion of a zig-zag to indicate a break in an axis is *not* recommended. Please note that if candidates do use this technique, the line of best fit must not be extended into this region. While some benefit of doubt could have been given here, lines of best fit were sometimes unequivocally wrong. Some candidates assigned a value of x of zero part way along the x-axis, and candidates had extended lines of best fit into this region, effectively into negative values of x, which is clearly wrong. So in instances where the plotting of points was generally carried out to a good level of accuracy, or accurately drawn range bars added, marks could not exceed five in these instances owing to the inappropriateness of the line of best fit. Many candidates need to appreciate that a line of best fit could be a curve; some tried to assign straight lines to trends in data when a curve would have been more appropriate.

There was clear evidence this year that many Centres were more stringent in checking candidates' plotting of points before awarding marks. There were still many instances, however, where graphs drawn without appropriate scales, incorrectly plotted points and poorly-drawn lines of best fit, were on numerous occasions incorrectly awarded high marks, quite often eight.

The scales chosen by candidates sometimes made difficult accurate plotting of data; while candidates should be encouraged to use as much of the graph paper as possible, this should not compromise the accuracy of the graph. The use of millimetre graph paper is not recommended at this level, as this will make calculation of scales more difficult and may therefore not be conducive to the accurate plotting of points. Centres should note that the use of squared paper, rather than graph paper, is not appropriate for any but the lowest marks.

Please note that at 7-8 marks, assessment of work is made *solely* on the plotting of, and accuracy of range bars; assessment of the appropriateness of the line of best fit is at 5-6. Some Centres were clearly awarding seven marks for a not quite perfect graph, which is not appropriate.

In a few instances, however, Centres overlooked the fact that slightly higher marks should have been awarded in Strand E, where candidates had been awarded very low marks having drawn very poor graphs but could have been awarded three or four marks owing to their calculations of means. A small number of candidates had calculated gradients, rates as inverse relationships and standard deviations but had not been given high marks; instead, Centres appeared to base their judgements solely on the quality of graphs.

Centres are reminded that for candidates to be awarded marks in the 5-6 mark band and higher, graphs having gridlines should be produced. Where computer software is used to generate graphs, these should have appropriate scales, appropriate labelling, and gridlines. For candidates to score high marks, graphs require major and minor gridlines to be included while lines of best fit and range bars should be drawn manually. Again, in the computer package, the area of the graph can be assigned appropriately and does not have to begin at 0,0.

It is strongly recommended that all Centres ensure that candidates are taught skills, and emphasise care and accuracy in drawing graphs. Perhaps a check-list could be issued to candidates?

Strand F: Evaluation of data

In this strand, any discrepancies between Centre and Moderator marks resulted from Centres' misinterpretation of the marking criteria and candidates' failure to fulfil the requirements. It was clear that the approach adopted by many was one of a traditional approach to evaluation, with candidates looking for problems with the technique and suggesting improvements. Strand F is concerned with *evaluating the quality of data*.

In the current 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.

For 3-4 marks, candidates should identify outliers, either in tables of results or by written identification. In many instances, pieces of data were circled or otherwise highlighted in tables, but there was no key to designate these as outliers. The marking criterion states quite clearly that the candidate should identify 'individual results' that are beyond the range of experimental error; some candidates, erroneously, are *continuing* to designate means plotted on graphs as outliers. If no outliers are deemed by candidates to be present, justification must be provided. Though a statement was often made to this effect, a basic justification was frequently not forthcoming. It was also notable that many candidates alleged that they had no outliers because they had carried out several repeats, missing the point that this judgement should be based on quality of data.

For 5-6 marks, although there were some often good discussions of spread of data, 'repeatability' was not always discussed (candidates should be discouraged from the use of the term 'reliability'). At this level, the spread of data should be discussed qualitatively, along with the potential accuracy in terms of this spread and the closeness of points to a line of best fit.

For 7-8 marks, the spread of data should be discussed quantitatively. Candidates attempted this, using calculations of percentage uncertainty/error and standard deviation, with varying success. Identification of outliers could have been made by determining interquartile ranges where large sets of data had been collected. The Biology Practical Data Analysis was conducive to this, addressing criteria in both Strands F and E.

At this level, many candidates had often made an attempt to account for outliers, discussing possible sources of error arising from experimental techniques. Rarely did these discussions attain the 7-8 mark level. Even when pertinent points were made, as marks are awarded hierarchically, high Centre marks could often not be upheld if candidates had not matched fully the criteria at the 5-6 mark band level.

Candidates' evaluations were often overly long, with many candidates covering the pertinent points in the first few sentences. Moreover, candidates writing long evaluations were also prone to contradicting themselves. As stated above, there were many instances where candidates had also written lengthy sections on improvements to the experiment, when this is *not* required for the Practical Data Analysis (but is for the Practical Investigation).

Strand G: Reviewing confidence in the hypothesis

This strand was marked rather generously 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 to the hypothesis at all, or say if their data supported it. In some Centres, the hypothesis had been translated into a prediction (which is accepted under the marking criteria), but Centres should exercise care in ensuring that it is an appropriate translation of the hypothesis provided by OCR.

All candidates should make at least a statement referring to whether the hypothesis has been supported (or not), describe trends, then at the 5-6 mark band level, the extent to which the data support the hypothesis. Candidates working at higher levels should discuss *extra data* that could be collected (and not modifications to the experiment or analysis of the data already collected) to increase confidence in the hypothesis. At the 3-4 mark band upwards, candidates should make reference to some science when explaining their results. Note that while the inclusion of science in the introduction might be desirable, it is imperative that this appears in the review section. On many occasions, very little science was evident, limiting the mark to three. When candidates' reviews didn't meet fully the criteria, a partial match to the mark band could be supported by the quality of written communication.

For the 2016 tasks, the relevant science should have included:

How do different plant species affect each other

The limited numbers of candidates that undertook this task investigated the percentage cover of different plant species at different distances from trees. In Strands E and F, perhaps some opportunities were missed to include some statistics in analyses.

- At **3-4 marks**, many candidates related the trend in data to basic science, with an increase in the distance from the hedge or tree leading to increasing growth of a wider range of plants.
- At **5-6 marks**, many candidates explained the 'extent to which' the hypothesis can account for the data by describing the trend in more detail (using the appropriate terminology, where appropriate, e.g. positive correlation, negative correlation). Candidates linked this with competition and a number of factors, such as the plants having to compete with the hedge/tree for light, water and mineral elements.

- At **7-8 marks**, candidates needed to have given a detailed outline of extra data that could be collected to increase confidence in the hypothesis. This may have included investigating biodiversity, where species number or density were investigated, and vice versa.

  One valid suggestion would have been the collection of additional data at different locations but for identical types of habitat, or tree or plant species, as several factors may come into play.

  There may be a sharp transition between complete, or virtually complete, inhibition of growth and a marked increase in the growth of other species, so the collection of data at smaller, specified increments around this transition may be relevant.

Salt mining

- At **3-4 marks**, many candidates discussed the idea that an increase in temperature increases particle movement and therefore increases the rate at which the particles in water and those that make up the sodium chloride mix, i.e. the sodium chloride dissolve.
- At **5-6 marks**, many candidates explained the 'extent to which' the hypothesis can account for the data by describing the trend in more detail (using the appropriate terminology, where appropriate, e.g. positive correlation, negative correlation), and referred to the idea of dissolving as a breaking up of the crystals of salt (and often went further, in linking this with the 'breaking of bonds'). Candidates working at this level related these ideas to *energy*. They connected the increase in temperature of the water to the input of heat, influencing the energy available for the solution process (breaking up crystals/breaking bonds/lattices).

  At this level, many candidates explained the process using kinetic theory and referred to collisions between particles, describing these as being sufficiently energetic to break bonds/ crystals/lattices, or used words to that effect.

  Note that the terms ion and 'lattice' are not dealt with until C4.3, and ions in crystals until C5.2, so although some candidates discussed these, OCR was not expecting this.
- At **7-8 marks**, some candidates gave a detailed outline of extra data that could be collected to increase confidence in the hypothesis. This involved the investigation of the rate of dissolution of another compound/ion species at different temperatures.

Solar panels

- At **3-4 marks**, many candidates related the trend in data to basic science. Here, we were looking for a trend and some basic science e.g. the more area hit, the more voltage as more light is absorbed.
- At **5-6 marks**, many candidates explained the 'extent to which' the hypothesis can account for the data by describing the trend in more detail (referring to the shape of the graph).

  Candidates used a bit more science, e.g. ideas of light/radiation being emitted, travelling in straight lines very quickly, and photons/energy is absorbed. Many candidates described/explained how light releases electrons from the solar cells to produce an electric current/voltage/power, often to excellent effect.
- At **7-8 marks**, a small number of candidates gave a detailed outline of extra data that could be collected to increase confidence in the hypothesis. This included testing different types of solar cell, e.g. monocrystalline silicon or thin film, if the type used was polycrystalline (though we were not necessarily expecting these by name). Also permissible was to test if the hypothesis held true with different light sources.

In all Practical Data Analyses, at the 7-8 mark level, candidates attempted to give a detailed outline of extra data that could be collected to increase confidence in the hypothesis. Many thought, erroneously, that this was tantamount to suggesting improvements to the way in which the original experiment was carried out. In many instances, this aspect can be achieved by the collection of data using smaller increments (which must be specified, rather than being referred to vaguely) of the independent variable, particularly where the relationship was non-linear or

across any transitional phase, but many suggestions as to how increased confidence in the hypothesis can be effected will be dependent on the task itself.

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

- A 'Guide to Controlled Assessment' handbook for Unit A144 (Case Study and Practical Data Analysis). The direct download link is http://www.ocr.org.uk/Images/68604-guide-to-controlled-assessment.pdf
- Student-orientated guidance on evaluating sources and articles during their research. The direct download link is http://www.ocr.org.uk/Images/68542-unit-a144-case-study-preparation-evaluating-sources-of-information.pdf
- Candidate style answers. Exemplars of student work to illustrate the difference between the higher mark bands. The direct download link is http://www.ocr.org.uk/Images/295380-unit-a144-candidate-style-answers.pdf
- INSET materials from OCR's training events are now available to download for free from our website.

  The direct link to the Unit A144 INSET training materials is http://www.ocr.org.uk/Images/72970-inset-materials-oscs6-unit-a144-getting-started-managing-controlled-assessment-case-study-and-practical-data-analysis.zip
- We offer a free Controlled Assessment Consultancy service, in which candidate work that you have marked will be reviewed by a senior moderator prior to moderation. To do this, send photocopies of three pieces of marked, annotated work for the 2017 series to:

  The Science Team, OCR, 9 Hills Road, Cambridge, CB1 2EU.

  To make use of this service, post photocopies of three marked pieces of work to the following address: *Michelle Hawley, Science Subject Team, OCR, 9 Hills Road, Cambridge, CB2 2EU.*

  We advise you to send scripts from across the range of your marking. Please accompany the scripts with a letter on centre-headed paper detailing any issues and providing us with an e-mail address where the report is to be sent. This service can take up to six weeks so the scripts should reach us by 15th March at the latest.

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

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553