OCR
Oxford Cambridge and RSA

GCSE

Science A

Twenty First Century Science Suite

General Certificate of Secondary Education **J241**

OCR Report to Centres June 2014

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

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

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

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OCR REPORT TO CENTRES

A161/01 – Twenty First Century Science A (B1, B2, B3) Foundation Tier

General comments:

Overall, candidates appeared to find the paper straightforward, with most questions being attempted. Very few sections were unanswered suggesting that the paper was accessible to most candidates.

Attempts at the six-mark extended-writing questions suggested that candidates were prepared for this type of question; however Centres need to ensure that candidates know that unless they address all sections of the question in detail they will not achieve a Level 3 mark.

There was evidence of some candidates struggling with the mathematical content of the paper. Centres should be reminded to address the mathematical skills outlined in Appendix C.

The paper was suitably challenging and discriminated well between candidates. Despite some tailing off of responses towards the end of the paper, time restraint did not seem to have been a problem for most candidates.

Comments on individual questions:

Question 1

(a) This question was answered well with a large proportion of candidates scoring both marks .Those candidates that did not score any marks seemed to confuse the symptoms for Cystic Fibrosis with those for Huntington's. Of those candidates gaining one mark it was observed that often candidates chose one symptom for both Huntington's and Cystic Fibrosis.

(b) (i) Most candidates successfully completed the punnett square and gained both marks for this question. Centres should remind candidates to take care with the letters used to complete the punnett square and ensure that the difference between the lower case letter and upper case letter is clear. There were occasions when this difference was not clear and resulted in marks lost. Examiners were instructed to use an error carried forward for the second marking point to ensure candidates were not penalised for the same mistake twice.

(b) (ii) Candidates found this question particularly difficult even if marks had been awarded in part (b) (i).

There appeared to be a misunderstanding as to the genotype which would give rise to Cystic Fibrosis with many candidates incorrectly identifying Tt. As a result common incorrect answers were 75% and 50%.

(c) The vast majority of candidates scored one mark for this question more often than not for the identification that a benefit would be to plan treatment for the baby. Many candidates stated a benefit and a risk but did not develop this further to identify that the benefits outweigh the risks and therefore did not gain the second mark.

(d) Generally this question was answered well. Common incorrect answers made reference to potential harm to the mother or the inaccuracy of the test.

Question 2

(a) A surprising number of candidates did not score a mark for this question. Common incorrect responses included the use chromosome numbers (23) or single letters (X or Y).

(b) (i) This mathematical question did not appear to cause candidates any problems and the majority were awarded the mark.

(b) (ii) Candidates found this second mathematical question difficult with few candidates scoring any marks. Common incorrect calculations included adding 1.2 to 1000 or dividing 1000 by 1.2. A higher number of candidates did not attempt this question compared to other questions.

(b) (iii) This also proved to be a difficult question. Those candidates that did score 2 marks were often awarded the marks for identifying that the ratio could have been a result of the termination of female fetuses. Those candidates gaining one mark frequently did so for reference to gender selection. Many candidates were familiar with China's one child policy but did not always apply this knowledge effectively. Incorrect responses included suggestions that the male chromosome/gene may be stronger.

Question 3

3 This was the first six-mark extended-writing questions. A large range of responses at all levels were observed with many candidates achieving Level 2 and Level 3. Candidates provided good, detailed descriptions and examples of both genetic and environmental influences. Unfortunately some candidates did not discuss both elements and in these cases the mark was limited. Fewer candidates identified characteristics that would be influenced by both genes and the environment, which again limited their mark. A common error made by candidates was in the selection of a characteristic determined solely by the environment, many candidates incorrectly identified height and weight. Examiners were pleased to see full and very good answers to this question.

Question 4

(a) Many candidates gave a good description of the method that could be used to measure the pulse rate and came very close to scoring a mark for this question, but failed to then explain that the beats should be counted over a period of time and subsequently lost the mark.

(b) (i) The majority of candidates were able to use the formula given to calculate the cardiac output. Those candidates that did not appear to use a calculator often got an incorrect answer.

(b) (ii) A surprising number of candidates did not appear to know how to calculate the range for this data. Many answers were expressed with the higher number given first. Candidates should be reminded how to present the range. Examiners were instructed to use an error carried forward from part (b) (i) to ensure candidates were not penalised for the same mistake twice.

(b) (iii) This question was generally well answered though some candidates failed to gain the mark due to a reversed order or the presentation of the pulse rates, rather than the individuals names .

(b) (iv) The majority of candidates correctly identified one or both reasons as to why the order of fitness presented could be incorrect.

Question 5

(a) This mathematical question proved more demanding. Many candidates struggled to use the formula provided to generate a correct answer and failed to identify that r was the radius of the zone of inhibition. Common mistakes observed included π^2 or r x 2. Those candidates who understood the formula gained two marks.

(b) Candidates were asked to use data to draw conclusions from the results. Candidates who did not score in part b were not disadvantaged in this question as the correct answers could be identified despite an incorrect answer to part a. A range of marks were observed for this question. A common error made by candidates was the identification that 'water kills more bacteria than any antibiotic' and that 'antibiotic C must be water'.

(c) This question proved more difficult. Candidates found it difficult to explain why it was important that all the paper discs were the same size. Many candidates scored one mark for using the term 'fair test', but struggled to express what they meant by this term and could not relate it to the investigation. Centres should be encouraged to address this problem. Very few candidates stated that using the same size paper discs allowed a fair comparison of the antibiotics and even fewer candidates were able to relate the size of discs to the same amount of antibiotic used in each test.

(d) The vast majority of candidates answered this question well. They were able to explain that new antibiotics were tested both for safety and effectiveness. These reasons were expressed in many ways.

Question 6

6 This was the second of the six-mark extended-writing questions. Again a range of responses were observed for this question. Candidates awarded Level 1 often had difficultly describing the correlation presented and failed to identify other factors that demonstrated similar correlations. Many candidates were awarded Level 2 for the correct identification of obesity, smoking, salt, alcohol or drug abuse as factors with similar correlations. Fewer candidates were awarded Level 3 as, although factors were identified, the expected correlation which would be observed was not stated. Some candidates lost marks for stating that 'drinking' would present a similar correlation without highlighting that it was alcohol which was being consumed. Factors less commonly discussed included stress, age and high blood pressure.

Question 7

(a) (i) The majority of candidates scored one mark for this question, correctly identifying that the number of extinctions was increasing. Fewer candidates correctly identified that there was no initial increase.

(a) (ii) The vast majority of candidates scored the mark for this question, those failing to gain the mark frequently gave the number of extinctions as just below 40,000.

(b) (i) The majority of candidates gained one mark for this question for correctly identifying a consequence of increased population. A good range of answers were observed, demonstrating candidates' knowledge of the consequences of an increasing population. Many candidates went on to develop this answer providing a result of the consequence identified. Some candidates lost the second marking point for stating two consequences rather than developing one.

(b) (ii) Many candidates lost the mark for this question for simply identifying the section of Boris' statement that was incorrect. Although this in part was correct they failed to develop the answer and explain why this was the case and as a result could not be awarded the mark.

(c) The vast majority of candidates scored both marks for this question, correctly identifying why biodiversity is important.

Question 8

8 This six-mark extended-writing question was common with the Higher Tier and, as anticipated, candidates found this extended writing question the most difficult. Many candidates did not have a good grasp of the processes of selective breeding and natural selection and as a result found talking about their similarities and differences problematic. Many candidates gained marks for the correct identification of a feature of either natural selection or selective breeding or in many cases features about both. Unfortunately many candidates were unable to develop their answer and make a comparison of the two processes. Common similarities discussed included the correct identification of both as methods of breeding and the processes involving the selection of favourable characteristics. A common difference frequently observed highlighted the human control of selection in selective breeding and the lack of this in natural selection. Some candidates did confuse selective breeding with gene manipulation and IVF.

Question 9

9 Candidates did not appear to have a good working knowledge of the carbon cycle and as a result this question was often one that candidates struggled with.

(a) A range of answers were observed for this question, with many candidates correctly identifying all three processes.

(b) A surprising number of candidates could not identify that the animals were eating the plants and those that did identify this often failed to develop the answer further.

(c) Candidates also found this question difficult. Very few candidates understood the role of micro-organisms. Those that did, however, often went on to score two marks for this question.

A161/02 – Twenty First Century Science A (B2, B3, B4) Higher Tier

General Comments:

Candidates demonstrated that they had secure knowledge of many aspects of the specification, such as construction of genetic diagrams, discussing the implications of testing for genetic disorders, factors that can increase the risk of heart disease, how to measure pulse rate and how new drugs are tested. The majority of candidates were able to process data confidently to calculate the mean of experimental results and work out probabilities.

Candidates did not seem to have the knowledge or skills required to respond to questions about perception of risk, interpretation of practical results on antibiotic activity and explaining how gender is determined by the sex-determining gene on the Y chromosome. Other areas of the specification that candidates did not perform well on include recycling of carbon through the environment, comparing natural selection to selective breeding and being able to explain the meaning of a fair test and why it is important.

Comments on Individual Questions:

Question 1

(a) This was a well answered question. Many candidates were able to produce a correct genetic diagram and probability. Some candidates limited their mark by not using the letters provided.

(b) (i) To get the mark for this question, candidates needed to identify either 'more fetal cells' or 'no need to separate maternal from fetal cells'. Answers linked to accuracy/reliability did not get the mark.

(b) (ii) Many candidates were able compare the methods given and give an advantage for the new one.

(c) Candidates demonstrated secure knowledge in relation to genetic testing. Good responses were able to discuss in detail a variety of relevant factors.

Question 2

(a) Good responses linked chromosomes to the correct gender. Answers using genes or DNA did not get the mark.

(b) This was a challenging question. Candidates needed to know about the sex-determining gene on the Y chromosome and how it has its effect on gender.

Question 3

(a) Most candidates were able to give all 3 correct responses to this question.

(b) Many candidates knew the implications of a genetic test in relation to insurance companies and so scored at least 1 mark.

(c) The best responses were able to utilise the idea that perceived risk is different to the calculated one.

Question 4

(a) This was a well answered question. Where candidates did not get the mark, they either described a method with no measurement or used an incorrect unit of time.

(b) (i) 6900 was the correct response.

(b) (ii) Most candidates were able to process the data accurately and identify the correct person.

(b) (iii) The best responses recognised that pulse rates can vary in addition to stating a way of increasing the confidence in the results.

Question 5

(a) Most candidates were able to calculate correctly the total area of A.

(b) A good discriminator. Only some candidates were able to link correct descriptions to explanations and conclusions. Recognition that clear areas were due to antimicrobial action was required to gain level 3 marks.

(c) Good responses were able to explain what a fair test is and why it is important.

(d) This was a well answered question, demonstrating that candidates have secure knowledge on how drug trials are carried out.

Question 6

(a) (i) Most candidates were able to give the 2 correct responses required.

(a) (ii) it was encouraging to see that most candidates could interpret the graph correctly.

(a) (iii) The best responses were able to describe the correct trend and explain it in relation to human activities.

(b) (i) Most candidates were able to identify a relevant method to prevent extinction of species.

(b) (ii) The best responses were able to produce two reasons why preventing extinctions is important to the environment.

Question 7

(7) This question differentiated well. Good responses were able to provide a number of similarities and differences between natural selection and selective breeding.

Question 8

(a) Most candidates were able to give the 3 correct responses required.

(b) This was a challenging question. Responses needed to include the importance of recycling carbon as well as describe a transfer process.

(c) This was a challenging question. The best responses were able to explain why not all of the carbon had been transferred to the fox. Responses which discussed energy transfer did not gain marks.

A171/01 – Twenty First Century Science A (C1, C2, C3) Foundation Tier

General Comments:

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

Comments on Individual Questions:

Question 1

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

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

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

Question 2

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

(b) Almost all candidates could describe the general shape of the graph. Most candidates could also describe the three individual sections of the graph.

(c) (i) Around half of the candidates could identify the statement was describing 'a correlation'.

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

Question 3

(a) Generally well answered, with most candidates identifying carbon dioxide as the correct response.

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

Question 4

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

(a) (ii) Almost all candidates could identify the range

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

(b) (i) &(b) (ii) Both were well answered.

Question 5

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

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

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

Question 6

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

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

Question 7

(a) (i) Candidates found it difficult to identify both correct responses for the 1 mark.

(a) (ii) Candidates performed much better on this question, where only one tick was needed for the mark.

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

(a) (iv) Most candidates scored this mark for the idea that salt is used to improve the taste or flavour of food.

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

(b) (ii) Candidates struggled to correctly identify potassium hydroxide as the correct answer. The most common incorrect answers was potassium oxide.

Question 8

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

Question 9

(a) The majority of candidates couldn't identify chlorine as the correct response.

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

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

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

A171/02 – Twenty First Century Science A (C1, C2, C3) Higher Tier

General Comments:

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

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

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

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

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

Comments on Individual Questions:

Question No.

Question 1

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

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

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

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

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

Question 2

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

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

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

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

Question 3

(a) (i) Almost all candidates could correctly calculate a mean.

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

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

Question 4

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

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

Question 5

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

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

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

Question 6

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

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

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

Question 7

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

Question 8

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

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

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

A181/01 – Twenty First Century Science A (P1, P2, P3) Foundation Tier

General Comments:

It was pleasing to see that candidates had engaged well with the content of the course. They demonstrated their acquired knowledge and skills in their answers to the questions. Most candidates performed well when required to tick boxes, write, or ring words. They followed instructions carefully and made their new response clear when they changed their mind. Many candidates wrote good answers to most of the short answer questions, especially those which required them to demonstrate their knowledge. Some candidates had difficulty with the questions that required them to interpret information they were given.

In the six-mark extended writing questions many candidates communicated well, showing good skills in English writing, regardless of whether the content of their answer was appropriate. Those who took care to answer all the points in these questions scored high marks. Some candidates found it difficult to apply their knowledge to the particular question, and answered a related but different question. It was pleasing to see that most candidates attempted these questions. Some candidates used a lot of words to say very little, while others conveyed the important points in few words. As long as they were clear, both concise and longer answers were equally acceptable.

Most candidates had good basic mathematical skills, and some wrote manual calculations which could have been done more quickly with a calculator. Some had difficulty in deciding which mathematical operation was appropriate to the question, showing difficulty in understanding the problem. Many students were challenged by questions that required them to interpret data and then give an explanation.

Comments on Individual Questions:

Question 1

(a) (i) Most candidates ticked the correct box. These candidates were not distracted by, 'Smaller planets are more distant from the Sun.'

(a) (ii) Many candidates gave an acceptable estimated value. Some could explain how they had arrived at their estimate. Good responses used the data for both Earth and Jupiter.

(b) This was consistently well answered. Good responses correctly differentiated between 'comets' and 'asteroids'

Question 2

(a) (i) Almost all candidates ticked at least one correct box and most ticked two.

(a) (ii) Many candidates wrote answers that differentiated between the P waves and the S waves. Some candidates knew that one type of wave stopped while the other carried on, and some knew that it was the S waves that stopped (or the P waves that continued). Candidates needed to understand that the diagram was incomplete and did not show that both waves stopped.

(b) (i) Some candidates scored for this question aimed at higher ability candidates. To get the marks for this question, candidates needed to state the time delay and then multiply their delay by 8 km/s. Showing their working sometimes scored a mark in case of error.

(b) (ii) Candidates needed to write down a calculation that showed the rule worked at 2000 km for 1 mark, or write down a calculation that showed the rule did not work at 4000 km for 1 mark. Both of these calculations scored 2 marks.

Question 3

(3) Good responses addressed both parts of this six-mark extended writing question to achieve level 3. For the telescope improvement, candidates needed to mention an improvement such as better lenses, computer tracking, putting telescopes on top of mountains or reducing atmospheric interference. In the question, 'telescopes on Earth' hinted at using space telescopes, or the Hubble telescope.

Many candidates identified a method of distance measurement to achieve level 2. They often described how distance was measured by brightness. Some candidates successfully described using parallax. Red shift was chosen only rarely. Some candidates achieved level 2 for telescope improvement.

Many candidates wrote a clear well expressed answer, but one that repeated the information given in the question and added the one key fact they knew, which was that technology had improved. This generic improvement qualified as a level 1 response, for 1 mark.

Question 4

(a) Many candidates scored at least 2 marks for identifying which statements about photons and radiation were false and which were true.

(b) This question proved to be too difficult for candidates. They needed to remember and use the fact that intensity = photon energy x number of photons. It appeared that most thought they were being asked to extract information from the table.

Question 5

(a) To get marks for this questions candidates needed to state that 'the ozone protects us by absorbing the radiation'. Some candidates knew the correct scientific words 'ozone' and 'absorb'.

(b) Most candidates were able to give a method of protection against ultraviolet radiation. Some explained how their method worked, for example by absorbing radiation or reducing exposure.

Question 6

(6) Most candidates understood that the radiation, whatever it was, was safely contained inside the oven. Many candidates knew that microwave ovens use microwaves not gamma rays.

Question 7

(7) In answer to this six-mark extended writing question, it was pleasing to see that the majority explained how the graphs showed a correlation and achieved at least level 2. For level 3, some correctly identified the mechanism as the carbon dioxide in the atmosphere.

Question 8

(a) The majority of candidates ringed the correct response.

(b) Many candidates scored for saying that computers allowed you to edit the images. For a second mark some candidates suggested the ease of transferring or sharing images.

Question 9

(a) It was pleasing to see that most candidates knew that coal burning power stations produce greenhouse gases.

(b) It was pleasing to see this question so well answered by the majority. Some candidates needed to understand that 'in each power station, total energy input = total energy output'.

Question 10

(a) Many candidates successfully found the difference between the two readings. To get the mark here candidates need to understand that this is the same meter at 2 different times and a difference is needed, not a sum or a product.

(b) The large majority of candidates explained that summers were hotter and/or lighter and an associated behaviour that reduced electrical use.

Question 11

(a) (i) Some candidates calculated the kWh used by a fridge. Many candidates calculated Wh.

(a) (ii) Some candidates scored the mark for correctly calculating the cost, or the cost of their answer to Q11(a)(i).

(b) Most candidates gave a comparative answer and explained that the old fridge used less power, or that 20W was less than 150W.

Question 12

(12) It was pleasing to see that most candidates were able to interpret the table of data correctly and explain why 2500V should be used, referring to the energy or the power in their answers.

Question 13

(13) Almost all candidates attempted this six-mark extended writing question. It was pleasing to see that many candidates achieved level 3 by including a calculation in addition to addressing advantages and disadvantages. Most often this was the initial cost of the panels, but sometimes they calculated the electricity produced by 12 panels. It was also pleasing that most candidates achieved at least level 2 by identifying one or two straight-forward advantages or disadvantages. Often the advantages given were, 'provides free electricity', 'renewable' or 'no pollution'. Common disadvantages given were, 'initial expense', 'less electricity produced when low light level' or 'will not work at night'.

A181/02 – Twenty First Century Science A (P1, P2, P3) Higher Tier

General Comments:

This is the first examination series in which the 'mixed' science papers have not been available, with a resulting increase in the candidature for the separate science papers. Few candidates seemed to have been short of time, and examiners commented that the majority tackled the questions well in both extended writing and in mathematical aspects. Most answers were clearly and logically presented but there were a number which, though very good, were very difficult to decipher and these candidates may have lost marks due to this. A number of 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 great swathes of empty space.

The extended response (6-mark) questions were generally well attempted: it was regrettable that the established custom of putting questions in unit order resulted in the easiest 6-marker, which was also on the foundation paper, was at the end of the paper with the two more difficult ones towards the beginning.

Comments on Individual Questions:

Question No.

1 (Earthquakes)

Most candidates tackled (a)(i) well but some failed to negotiate the different stages needed to get to the answer. In (a)(ii) many did not justify their answer by calculation: many who had the right idea ended up with 1/2 after a paragraph of continuous prose while others had gained both marks after two simple calculations followed by brief comments. Part (b) proved much more demanding. The stimulus diagram was meant to indicate to candidates that the path from earthquake to detector went nowhere near the core, just visible at the bottom, but unfortunately the sight of the core led many to discuss the behaviour of P- and S- waves on reaching the core.

2 (Distant galaxies)

The very best candidates wrote coherent answers to this question, drawing on relevant knowledge and linking the improved observations to relevant new scientific ideas. Weak candidates who were unable to do this were often able to describe some improvement in observations. Those Physics candidates (as distinct from Science candidates) who used knowledge from unit P7 were given credit, although this was not required in the question..

3 (Planetary orbits)

(a)(i) and (a)(ii) were well done, but (a)(iii) revealed many blind spots in candidates' understanding of numbers. Even though the calculations were almost invariably correctly done in (a)(ii), only a very few candidates realised that the 'constant' hypothesised by the two scientists were much closer for H (135 000 and 128834.3) than for R (4500 and 19 229), with a significant number preferring R's model for reasons such as: R's values look nicer, without decimals; H's numbers are almost the same, but Uranus is further from the Sun so should have a bigger number. A small number correctly suggested that the models needed to be applied to the other planets to test the models more effectively. In (b), most could suggest distinct features of asteroids and comets, although there were a number of odd misunderstandings.

4 (Global warming)

The objective part (a) proved testing: most had two or three of the five true-false choices correct. The extended part (b) showed how important it is for candidates to read the question carefully and answer exactly what is asked. The fact that carbon dioxide was not mentioned in the question stem should have triggered an awareness that it should be discussed. Some good candidates understood the mechanism for global warming but made no reference to human activity in their answer, although expressly asked to explain this in the question. Weaker candidates often confused global warming with damage to the ozone layer. Students found it difficult to explain why the opinions of scientists differ on the issue. The most popular comment was to say that some think global warming has natural causes, with more able candidates expanding on this to reference evidence from ice cores and/or examples of natural phenomena which contribute to greenhouse gas emissions, such as volcanoes, or changes in the Earth's orbit, or fluctuations in the Sun's activity.

5 (Photons)

The true-false objective part (a) was answered a little more successfully than in question (4), but (b) scored very poorly, with over a third of all candidates leaving it untouched. There was no awareness that the total energy must be the number of photons × the photon energy, and very few candidates managed one mark by correctly stating that, as the green photons have less energy, there must be more of them to give the same intensity. The fact that this question used standard form also made it more difficult.

6 (UV and risk)

Most obtained one mark in (a), which was testing recall of the name of the active chemical and the correct use of the terms absorb/emit/reflect/transmit – in this case, absorb. Part (b) was generally well done with many suggesting not only a benefit of sunbathing but also a consideration of the risk.

7 (Digital data)

Candidates who read the question carefully and used the information in the table often scored all 3 marks. They did this either by calculating that a modern photo is 25 times bigger or working out how many 3 minute songs or modern photos would fit on a 1000MB hard drive.

However, many candidates gave only qualitative answers, possibly referring to changes in social use of media (which gained a mark) but not using the data in the table. A few ignored the question and compared digital and analogue systems.

8 (Power stations)

Both objective parts proved difficult, with those scoring 1 mark in (a) generally knowing that the disadvantage of hydroelectricity is that it cannot be used in all countries. Many candidates did not realise that power stations need to pay for biofuel and there was evidence that some candidates were looking to give only 1 tick on each row, which perhaps suggests that they had not read or understood the question clearly enough and so were guessing. In (b), most were able to do the maths necessary for one or two rows of the table, with only a few per cent completing it all.

9 (New fridge)

The multi-stage calculation in part (a), with a number of hurdles to cross, meant that only about one candidate in six had the correct answer, which is less than guesswork as there were four options to choose from. In (b) 'error-carried-forward' from an incorrect choice in (a) allowed full marks for the correct processes, but surprisingly few realised that saving £182 000 in a year was not likely – this should have stimulated them to go back and reconsider their choice in (a). Reasons for not discarding the old fridge in (c) were often sensible, but many did not attempt this part having found the earlier, mathematical parts too demanding – they should have realised that this part was independent of them.

10 (Power lines)

The calculations of power wasted and power delivered in part (a) were generally well done, but only the best candidates carried these forward in to the descriptive part (b) where it was intended to trigger the response larger V $\Rightarrow$ smaller I $\Rightarrow$ less energy/power wasted, partly a direct recall from the specification and partly an interpretation of the table.

11 (PV panels)

This extended response 6-mark question was generally well done, with many candidates able to discuss pros and cons of installing the panels in both environmental and cost terms, supporting their answer by relevant calculations using the data provided.

A144 – Controlled Assessment

General Comments:

In this session, it was pleasing to see how many Centres administered, implemented and assessed the Controlled Assessment unit.

Overall, Centres are to be commended for their dispatch of samples; these began to arrive very shortly after the 15th May deadline for the submission of marks, and most were very well organised. Particular commendation is due to the Centres that were affected by the slowness of external administration and responded very promptly.

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

Rather fewer Centres this year provided their Moderator with detailed accounts of how the tasks and levels of control were administered; where present, these aided the moderation process. Documentary evidence of internal standardisation helped to confirm that correct procedures had been applied consistently, but for many Centres, this was lacking. 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. 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 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 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).

The effect of the different method used to aggregate marks across the unit (with a totalling of marks from each Strand/Aspect of Performance in A144, instead of an averaging of marks across a number of Aspects of Performance to provide each Strand mark in A219) continues to warrant caution, offering less room for error and putting more onus on the Centre to mark very carefully.

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 were sometimes omitted.

Comments on the two elements

The Case Study

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 News Sheet and on the Information for Teachers documents.

It was noted this session that rather fewer candidates' scripts this year were overly long. Although timings indicated in the specification are for guidance only, it was clear that in a small number of instances these had been exceeded markedly. It must be impressed upon candidates that producing reports in this skill area is an exercise in conciseness.
The choice of three topics for the Case Study for 2014 was:

DNA and genes
Electric cars
Wind power

The evidence suggests that the three Case Studies were, more or less, equally popular with Centres. The Electric Cars Case Study generated scripts with the science of most variable quality.

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 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 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 likely, 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. A document to help to develop candidates' skills in evaluating information sources is provided as Appendix I of this 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.

- **DNA and genes:** the nature of DNA and genes, along with, genetic and environmental influences on characteristics; disorders caused by faulty alleles; genetic testing; and gene therapy, as appropriate to the question posed.

- **Electric cars:** how electric cars work, along with how the internal combustion engine works; the combustion of petrol and diesel and air pollution; the generation of electricity from fossil fuels, and alternatives (that can be non-polluting when up and running); electric charging, as appropriate to the question posed.

- **Wind power:** how wind turbines produce electricity, along with, the generation of electricity using other means, as appropriate to the question posed.

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. Many candidates succeeded in doing this in part, but not completely. For gene therapy, for instance, which was a frequent area of study, candidates often gave a good account of the process, but not of the faulty genes or disorders it was meant to counteract. In the Electric Cars Case Study, the background science was very often sketchy. The science of wind turbines was often more comprehensively covered.

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. 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. As stated in the Information for Teachers, candidates' marks would be limited by concentrating solely or mainly on ethical issues. This was a particular problem for some candidates undertaking the DNA and genes Case Study. In this topic, there was also much confusion between the Human Genome Project and gene sequencing and forensic genetic profiling involving analysis of repeat sequences of a limited number of loci for forensic purposes.

Discussions often lacked precision, though many candidates working at higher levels analysed data supporting opposing sides of the argument. In particular, the DNA and genes Case Studies were often rather generic in nature.

Please note that it is also good practice for candidates to refer more often to the scientists or bodies carrying out the research that produced the evidence. In many instances, there was little evidence of use 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.

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. In the Electric Cars Case Study, it was interesting to note that many candidates used the terms 'gasoline' or 'gas' in their discussions, with no consideration of how they would refer to the fuel in everyday life.

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 this report, to assist further in the development of these skills.

In the 7-8 mark band, candidates are expected to critically review 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). 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.

C(b) – Conclusions and recommendations

In this Aspect of Performance, candidates should draw on selected information sources to draw a conclusion. Candidates usually presented this in a 'Conclusion' section, but this was often lacking in detail, even by otherwise high-scoring candidates. 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'. Although conclusions had been drawn, this was often not the case. The recommendations made based on candidates' conclusions were often vague, or somewhat generic, and for six marks, Centres should note that the marking criterion refers to recommendations, plural. Some questions posed did not always lend themselves to recommendations; there were some otherwise excellent reports based on the nature vs. nurture debate, but here, recommendations simply were not possible.

In the 7-8 mark band, candidates working at higher levels often discussed limitations to the conclusion, and alternative recommendations, but different interpretations of the evidence were more rarely seen. Candidates struggled to accrue marks at this level.

Practical Data Analysis

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 2014, these were:

Fertilisers
The hypothesis:
An increase in the level of fertiliser in water affects the growth of duckweed.
or
An increase in the level of fertiliser in water affects the growth of phytoplankton.

Testing the breaking strength of samples of poly(ethene)
The hypothesis:
The strength of a sample of a poly(ethene) bag depends on the width of the sample.

Wind turbines
The hypothesis:
The angle of the turbine to the wind direction affects the output power of the turbine.

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. Candidates in some Centres derived a quantitative prediction from the hypothesis provided, required for high marks in the Practical Investigation, but not in the Practical Data Analysis.

Centres should note that if the choice of variables related to the investigation is limited, it must be ensured that candidates are still able to test the hypothesis provided and access the full range of marks. For example, 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.

The poly(ethene) experiment was carried out by the vast majority of candidates.
In some Centres, in the Wind turbines task, candidates used potential difference as the dependent variable, rather than power. In these instances, ideally, somewhere in their write-ups, candidates should have discussed the relationship between potential difference and power, and/or assumptions made if their measurements were based on different potential differences alone. This was not always done, and without this qualification, strictly speaking, they did not truly test the hypothesis.

Centres are also 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, but this was not a serious problem in this session.

Comments on individual strands

Strand D: Choice of methods, techniques and equipment

Strand D was often generously marked. In this strand, candidates are expected to write a method suitable for testing the hypothesis. They often discussed variables, attempted to justify equipment used, and included other aspects in their write-ups, but in doing so, many then neglected to provide a coherent method. Also, 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. Please note also that to secure marks in the 5-6 mark band, repeats should be described in the method, and data collected must be 'of generally good quality'. 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 data points to plot.

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. Justifications, however, 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 some very mundane statements were seen. In this mark band, candidates should be using terminology such as 'resolution', 'accuracy' and 'precision' in their justifications. It should be emphasised to candidates that the way in which the criteria are accrued is hierarchical, so they would be better to focus their efforts in ensuring that responses to the lower marking criteria are in place and adequate.

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)
- the associated risk(s)
- measures intended to reduce risk.

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).

Main points *specific* to each task:

Fertilisers:
- follow good hygiene practice if handling any duckweed collected from ponds, or cultures of alga
- hazards and risks from fertilizers; Material Safety Data Sheets (MSDSs) can be found on the Internet for most of the proprietary brands.

Testing the breaking strength of samples of poly(ethene):
- hazards and risks from falling, certain size masses
- devices used to cut poly(ethene), where appropriate
- handling materials [clearly, very low from poly(ethene)].

Wind turbines:
- moving fan blades
- Portable Appliance Testing (PAT) of electrical equipment, i.e. the fan.
  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'. Though not applicable in this session's tasks, candidates should also consider hazards and risks of a final product of the experiment, e.g. the products of a chemical reaction or incubated agar plate. For a Risk Assessment to be 'appropriate', the hazard/risk must be commensurate with that for the chemical/equipment/activity used or undertaken. A good illustration of this would be when referring different concentrations of acids, where the hazard varies 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 the quality of graph work was much improved from 2013, though this improvement was not seen in 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.

Some graphs were, nevertheless, of poor quality. There was clear evidence that some Centres do not check candidates' plotting of points carefully before awarding marks. Graphs drawn without appropriate scales, e.g. where these were non-linear, or without one or more labelled axes, and poorly-drawn lines of best fit, were often, incorrectly, awarded high marks. 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. Candidates should also be discouraged from extrapolating lines of best fit to regions of the graph where no data have been collected/ plotted.

Scales used by candidates were sometimes problematic. 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).

If a scale is inappropriate, or points are plotted incorrectly, the candidate mark cannot exceed four, or in the latter instance, five. Likewise, if an inappropriate line of best fit has been applied, a mark above five cannot be awarded, irrespective of whether the candidate has drawn range bars. For marks to be awarded in the highest mark bands, range bars must be drawn accurately (in addition to there being minimal errors in the plotting of data). The scales chosen by candidates sometimes made difficult accurate plotting of data, as did points or crosses drawn with unsharpened pencils. 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.

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. In a few instances, however, Centres overlooked 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 be awarded three or four marks owing to their calculations of means.

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

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, with candidates looking for problems with the technique and suggesting improvements. This strand is concerned with evaluating the quality of data.

In the new (2011/2012) specifications for Twenty First Century Science, statement 1.6 in the 'Ideas about Science' has clarified the definition and treatment of outliers (compared with the version in the legacy (2006) specifications) to state:

"If a measurement lies well outside the range within which the others in a set of repeats lie, or is off a graph line on which the others lie, this is a sign that it may be incorrect. If possible, it should be checked. If not, it should be used unless there is a specific reason to doubt its accuracy."

Potential outliers in data collected during a Controlled Assessment should be handled in accordance with this statement.

Candidates are permitted to draw a graph of their results during the (limited control) data collection stage of the Controlled Assessment task. This may help them to identify potential outliers. Ideally, any data points that look to be potential outliers should be re-measured, and this is easiest to achieve if they are identified during the data collection session.

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.

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 error and standard deviation, with varying success. At this level, many candidates had often made an attempt to account for outliers, discussing possible sources of error arising from experimental techniques. Even when pertinent points were made, as marks are awarded hierarchically, high Centre marks could often not be upheld, as 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. 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 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), and the extent to which the data support the hypothesis. Candidates working at higher levels should discuss this in terms of data increasing confidence in the hypothesis. At the 3-4 mark band upwards, candidates should make reference to some science when explaining their results. On many occasions, very little science was evident. For the 2014 tasks, the relevant science should include:

- **Fertilisers**

At **3-4 marks**, many candidates related the trend in data to basic science, suggesting that an increase in the concentration of mineral elements, e.g. nitrogen/nitrates, led to increased growth.

At **5-6 marks**, candidates should have 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), adding, for example, that nitrate is used to synthesise proteins that contribute to growth. Some of the more able linked this with enzyme production.

At high concentrations, some candidates observed and acknowledged an inhibition of growth. They referred to 'toxicity' owing to osmotic effects.

- **Testing the breaking strength of samples of poly(ethene)**

At **3-4 marks**, many candidates related the trend in data to basic science, linking the increase in strength to the increase in the width of the poly(ethene) strip to attraction between polymer molecules.

At **5-6 marks**, candidates should have 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). Many went on to add a description of the involvement of more intermolecular forces with increasing width. Some candidates referred to van der Waals' forces between the hydrocarbon chains. Many, erroneously, suggested that this was because of 'cross-linking' of chains. Many candidates were clearly encouraged to use sketches to illustrate the principles, often to good effect.

- **Wind turbines**

At **3-4 marks**, many candidates related their trend in data to basic science, i.e. stating that as the angle changes, the area of the blades/vanes in contact with the wind increased/decreased, so the rotor would spin faster/slower and more/less power was generated.

At **5-6 marks**, candidates should have 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). Again, many talked about the area of the blade in contact with the wind as the angle changes, and how the energy in the wind is transferred to the blades and makes them rotate. Many candidates said that the faster the blades rotate, the greater the output of the turbine.

Some referred to energy transfers – kinetic to electrical, and linked energy to power and time.

In all Case Studies, 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 experiment was carried out. In many instances, this aspect can be achieved by the collection of data using smaller increments (which much be specified, rather than being referred to vaguely) of the independent variable, particularly across any transitional phase, but many suggestions as to how confidence in the hypothesis can be effected will be dependent on the task itself. In the poly(ethene) experiment, many candidates (commendably) made mention of, or discussed, structures of high density poly(ethene) (HDPE) and low density poly(ethene) (LDPE), so it was a little disappointing that little referral was made to these when considering extra data that could be collected.

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
    - 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 Controlled Assessment Consultancy service, in which candidate work that you have marked will be reviewed by a senior moderator prior to moderation.

To make use of this service, post photocopies of three marked pieces of work to the following address: *Carolyn Brawn, GCSE Science National Support Coordinator, OCR, 1 Hills Road, Cambridge, CB1 2EU.*

Typically, we encourage Centres to send work (up to three Case Study scripts and three Practical Data Analysis scripts) which covers a range of attainment or which illustrates particular points of concern. The Controlled Assessment scripts should be marked and annotated before being photocopied. Please include a covering note on Centre-headed paper, and give a contact email address. A senior moderator will look at the work and will write a report on the Centre marking, which we will email or post back to you within 6 weeks. You can then make adjustments to your marking, if you wish, before submitting marks for moderation in May.

Appendix I: Judging a source of information

	 The further to the right, the more reliable the source is likely to be				
Publication / source	Website or newsletter of a private individual, 'blog' or forum entry from unknown writer.	'Respectable' pressure group website or newsletter.	'Quality' media, e.g. the BBC, The Guardian.	School textbook or science magazine, e.g. New Scientist, Catalyst.	Peer-reviewed journal or government report.
Nature of the data	Little or no data given.	Data of doubtful reliability, e.g. based on small or unrepresentative sample.	Based on a single study, or little information about design, procedures or samples.	Clear indication of valid design e.g. large samples, extended period of study.	Studies by different teams of scientists, give consistent, i.e. reproducible, results.
Science explanations	No explanation or data to support claim.	Explanation not yet tested or confirmed.	Can be compared with other possible explanations.	Agreed by most of the scientific community.	Fully agreed by almost everyone.
Status of the author	Individual of unknown background, or known extremist.	Science student or well-informed person. Journalist.	Teacher / science journalist/ professional scientist with expertise in a different field.	Scientist working in this field.	Recognised expert in the field.
Author's affiliation or institution	Non-science related.	Representing a particular view only (e.g. manufacturer, organisation with interest, or pressure group).	Independent, science-related source.	University, medical school, science institute.	Leading research centre / major company / government research centre.

Use this guide when comparing different articles in the media or other sources.

It will help you to decide which articles are most likely to be giving reliable information to support any claims made or opinions given.

Appendix II: Connectives

Illustrating	Adding to	Comparing
for example, for instance such as as shown by as demonstrated by in the case of	and also as well as in addition moreover what is more	*(similarities)* compared to similarly likewise in the same way equally as with
Cause and effect	**Emphasising**	**Comparing**
because/as as a result so therefore since consequently thus	in particular significantly more/most importantly notably especially indeed	*(differences)* compared with however but in contrast on the other hand whereas alternatively instead nevertheless despite this in spite of even so otherwise
Sequencing	**Qualifying/Restricting**	
firstly/secondly... initially finally subsequently after/afterwards meanwhile eventually	although except yet apart from however unless only if	

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