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Oxford Cambridge and RSA

GCSE

Science A

Twenty First Century Science Suite

General Certificate of Secondary Education **J241**

OCR Report to Centres June 2015

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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.

CONTENTS

General Certificate of Secondary Education

Science A (Twenty First Century) (J241)

OCR REPORT TO CENTRES

A161/01 – Twenty First Century 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, however Centres need to ensure that candidates know that unless they address all sections in detail they will not achieve a Level 3 mark on these questions.

On the whole candidates limited their responses to the available spaces and were therefore more precise in their answers, which was pleasing to see.

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

In general, candidates showed a good understanding of genetic inheritance. Candidates were not so confident in answering questions on the potential uses of stem cells and natural selection.

Comments on Individual Questions:

Question 1

1(a) This question tested candidates' ability to link the pair of alleles with the characteristic that would result from the combination. The majority of candidates correctly identified that two recessive alleles would result in the recessive characteristic and two dominant alleles would result in the dominant characteristic. However, relatively few candidates indicated that one dominant allele and one recessive allele would result in the dominant characteristic.

1(b) In this question candidates were asked to complete the table by ticking the correct symptoms for cystic fibrosis and Huntington's disease. This question was generally answered well. Many candidates correctly identified the symptoms for both cystic fibrosis and Huntington's disease and gained both marks. Some candidates did confuse the two genetic disorders and chose the correct pair of characteristics, but assigned them to the incorrect genetic disorder.

1(c)(i) This question asked candidates to consider whether any mistakes had been made when the Punnett square had been constructed. Many candidates chose to annotate the diagram, or redraw the Punnett square to indicate where they felt the mistakes had been made. This proved to be a very effective way of demonstrating their knowledge. Candidates did find it difficult to express the mistakes in a written form and often this is where marks were lost. An example which exemplifies this is when referring to the incorrect entry to box one of the Punnett square. Many candidates simply stated that 'the ff was wrong' and that 'it should be Ff', however, they did not specify which 'ff' they were referring to and therefore were unable to be awarded this mark. Over half of the candidates scored both marks for this question, with a further third scoring one mark.

1(c)(ii) Candidates were expected to use the correct version of the Punnett square in (c)(i) to predict the probability of Harold and Hilda's baby child having cystic fibrosis. Over half of the candidates were awarded this mark. Many successfully created a correct Punnett square to assist with their calculations. Candidates expressed this probability in a number of correct forms. Those who found this question a little more difficult often used the term 'likely' rather than a numerical answer to describe the probability of the baby having cystic fibrosis.

Question 2
This was the first of the six-mark extended-writing questions, and many candidates found this level of response question difficult. Candidates were required to give an explanation as to the reasons why a baby born to the same parents would be different to their sister, Poppy, and the child's parents. Many candidates failed to fully address the question and, whilst many candidates correctly identified the reason for these differences would be as a result of different genes, they often found it difficult to express and failed to attach this reason to Poppy or to the parents. This limited the candidates to a Level 1 answer.

Candidates were able to give other basic reasons as to why there were differences. These included reference to the role played by the environment and identifying that the baby could have been a different sex to Poppy. Some candidates referred to identical twins, highlighting that this would be the only occasion when the children would be identical. More able candidates introduced the idea of different allele combinations and random gamete fertilisation.

Occasionally candidates did not read the information correctly and talked about the new baby having a different mum or dad.

Question 3
3(a-d) This question presented candidates with statements about the possible future use of stem cells to treat intestinal problems in premature babies. Candidates as a whole found this question difficult. Parts a-c proved most difficult; candidates performed slightly better on part (d) with over half of candidates identifying the correct statement.

4(a)(i) In this question candidates were asked to describe the evidence from the diagram that a blood vessel was an artery. Many candidates performed well on this question, with over half gaining one or both marks. Candidates that did not score well lost marks due to the statements not being comparative. Some merely stated that Fred was correct as 'arteries have a thick outer wall' for example. Some candidates scored 0 for this question as they incorrectly claimed that Fred was incorrect and that Vessel A was a vein.

4(a)(ii) Candidates found this question very difficult. A small percentage of candidates identified valves as the feature. A common incorrect answer was blood.

4(b)(i) This question asked candidates to place the stages of a heart attack into the correct order. The vast majority of candidates gained at least one mark for this question. Most candidates were able to identify B, 'fatty deposits building up in the blood vessels supplying the heart', as the initial stage. Of those who did not correctly identify the first stage many did then proceed to place DAC in the correct order.

4(b)(ii) The second of the six-mark extended-writing questions was answered well by the majority of candidates with around three quarters of candidates being awarded a Level 3 mark. Candidates demonstrated a good knowledge of the risk factors for heart disease. The most commonly identified descriptions were lack of exercise, eating too many fatty foods and a diet high in salt. Candidates often referred to 'drinking', but failed to mention alcohol so did not gain credit; equally many referred to bad food or unhealthy food, but were not explicit with what they meant by bad. Some candidates were unable to move into Level 3 as they simply listed the factors rather than describing them. On occasion candidates did not answer the question in terms of lifestyle, but instead used the information from (b)(i) and referred to fats clogging up vessels.

4(c)(i) Candidates were asked to apply their knowledge of genetic testing to identify three benefits of genetically testing people before prescribing drugs. This question was answered well with most candidates gaining at least one mark and over half of all candidates correctly identifying all three benefits.

4(c)(ii) This question asked candidates to consider the ethical reasons why people might object to compulsory testing. Again this question was answered well with very few candidates failing to gain any marks on this question. Candidates scoring one mark on this question often did so for the response 'everyone should have the right to choose whether they are tested or not'.

Question 5

5(a) In this question candidates were provided with some data which showed the number of measles cases reported in South Wales over a period of nine months. Candidates were asked to describe the pattern shown by the data and use figures in their description. Approximately a third of candidates scored full marks for this question. Many candidates gave good descriptions of the data, identifying points of increase and decrease. Unfortunately some candidates did not back this up with figures and often when figures were included they were not attached to the correct month, therefore these candidates failed to gain full marks. On occasion candidates referred to seasons rather than the months as stated in the data.

Some candidates did struggle to comprehend the command word – describe and tried to explain the data giving reasons such as the warm weather contributing to spread or lack of vaccinations.

Some candidates found it difficult to write a description from the chart. Some went into minute detail describing every month whilst others glossed over the data set. Candidates should be encouraged to practise this skill in preparation for examinations.

5(b) This question presented candidates with some of the reasons why parents do not have their babies vaccinated.

5(b)(i) Candidates were asked to select which of the reasons showed the parent had properly considered their social responsibility. Around half of the candidates correctly identified the correct reason.

5(b)(ii) Candidates were asked to give a reason why the MMR vaccination should be made compulsory. Candidates found this difficult with only a third of candidates selecting the correct response.

5(b)(iii) Candidates were asked to select two people who had not properly considered the scientific evidence. This section was answered very well.

5(b)(iv) In this question candidates were asked to consider the risks and benefits associated with the MMR vaccination. Some candidates did not seem to understand the ideas behind vaccinations very well with over a third failing to score any marks on this question. Common errors which resulted in the loss of marks included referring to MMR as if it were one disease, the use of vague statements such as stating a risk as 'making them ill' or 'poorly' or as a benefit the idea of preventing 'diseases'. Candidates rarely used the term immunity.

Question 6

6(a)(i) This question asked candidates to correctly identify an outlier from the data set provided. Unfortunately around a quarter of candidates failed to gain this mark, which in part could be due to a nil response. It would be worth centres reminding candidates to look out for the marks awarded on the right hand side of the paper to ensure they do not miss out a question. That said, some candidates did seem to struggle with this question and could not correctly identify the outlier.

6(a)(ii) This question on the whole was not answered well with just over half of the candidates failing to gain any marks. Candidates did not seem well versed in how to calculate a mean. Many calculated the mode or median and many others included the outlier in the calculation showing that they had not read the question. Those that did perform the correct calculation often failed to round the number to the nearest whole number. The answer 10.25 was observed in a high proportion of the responses. On occasion this was rounded incorrectly to 11.

6(b) In this question candidates were asked to use the data to identify two statements that when taken together, could explain the data. A high proportion of candidates struggled to identify the correct conclusions with many candidates gaining no marks. Those candidates scoring one mark on this question for the correct identification of 'the water at site B is most polluted'.

6(c) This was the final of the six-mark extended-writing questions; it was the common question with the higher paper and discriminated well. In this question candidates were asked to explain the processes involved in three stages of the nitrogen cycle. A range of marks were awarded with those at Level 2 generally gaining credit for the correct identification of animals eating the plants, part B on the diagram, and the animals then dying and returning the nitrates to the soil , part C on the diagram.

Knowledge of process C was by far the best. Candidates frequently made reference to death, decomposition and faeces as methods of returning nitrates to the soil. The role of decomposers, however, was less frequently seen.

Knowledge of process A was more limited. Candidates were often vague in their descriptions and referred to the movement of nitrates into the plant as 'going in' they did not seem to understand that this was an active process. Very few candidates referred to the plants absorbing the nitrates through their roots.

Knowledge of process B rarely included more than a reference to plants being eaten. Very few candidates indicated that digestion was involved.

On occasion candidates did make reference to the nitrates being used to make proteins, but this was not seen often.

Few candidates scored 6 marks on this question.

Question 7

7(a) Just over two thirds of candidates correctly identified mutations as the correct name for a random change in a gene.

7(b)(i) In this question candidates were asked to use the information provided to complete the axis label on the graph and draw a line to show the relationship described. This question discriminated well; a full range of marks was observed. Candidates approached the graph in a variety of ways. The axis label sometimes had superfluous information in addition to the desired answer 'genetic changes'. Candidates should endeavour to be more concise in their axis labelling. Falling numbers of butterflies with mutations, as distance from the power station increase seemed difficult to translate into a downward sloping line. Those candidates gaining one mark predominately did so for the correct labelling of the axis.

7(b)(ii) This question asked candidates to consider why scientists could not be sure that the genetic changes were a result of the radiation. Candidates found this question difficult with many failing to attempt the question. Incorrect answers included suggestions about evolution or that the butterflies had come from elsewhere, rather than identifying that there were other factors that could be responsible for the mutations. Those candidates that did recognise that evidence was key to identifying radiation as a cause often failed to gain a mark as they stated that there was no evidence rather than a lack of evidence. Many candidates had misunderstood the correlation aspect of this question.

7(b)(iii) Again candidates found this question challenging. Candidates were unable to demonstrate an understanding of natural selection. Those that did gain marks for this question often gave an example of natural selection and seemed to find it easier to describe the process within a context that they had learned about. Some candidates incorrectly discussed selective breeding.

A161/02 – Twenty First Century 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 genetic testing, describing the formation of twins, how heart attacks are caused, the vaccination process and the stages in the nitrogen cycle. In terms of mathematical skills, candidates were able to manipulate formula successfully to calculate the cross-sectional area of a blood vessel. As well as being able to correctly predict the relationship between numbers of genetic mutations in a species to the distance away from a nuclear power station.

Candidates did not seem to have the knowledge or skills required to respond to questions about perception of risk, the relationship between genes, protein production and enzymes. Other areas of the specification that candidates did not perform well on include analysing data and drawing conclusions from it, explaining how an outlier result can impact upon results, defining the term sustainability and calculating a percentage increase.

Comments on Individual Questions:

Question 1
1(a)(i) Many candidates were able to provide the two correct genotypes. The distinction between the capital letter and the small letter had to be unambiguous to gain the mark.

1(a)(ii) The majority of candidates were able to identify the correct response.

1(b) Good responses demonstrated clear understanding of how cystic fibrosis is inherited and were able to prove why the statement was incorrect.

1(c) Candidates demonstrated secure knowledge in relation to concerns about genetic testing.

Question 2
Many excellent responses contained detailed descriptions on the origins of the identical twins A and B and the non-identical twin C. Others needed to discuss the differences between C and the identical twins in terms of alleles to gain the higher marks.

Question 3
3(a)(i) This was a well answered question. Where candidates did not get the marks, they had not given the answer to the required number of decimal places.

3(a)(ii) This was a challenging question. Candidates had to describe the relationship between the wall thickness of the blood vessel and pressure in the correct context to gain the marks.

3(b) Candidates who were able to produce a logical account of how the physical processes leading up to a heart attack, as well as discussing the risk factors, achieved the highest marks.

3(c)(i) The majority of candidates were able to identify the three correct responses in relation to the benefits of genetic testing.

3(c)(ii) Most candidates could identify the two best ethical reasons against genetic testing.

Q3(d) This question was difficult as it relied on candidates' knowledge of how genes code for proteins and then putting this into the context of how enzymes work on drugs in the body.

Question 4
4(a)(i) The correct response was 700%.

4(a)(ii) A good discriminator. Only some candidates were able to give three reasons why the data was of concern to doctors.

4(b) Most candidates could successfully link the shape of the graph to the two correct explanations.

4(c) This question tested the full range of abilities. Many candidates could explain how actual risk is different from perceived risk. Some candidates struggled with this idea in the context of the question.

Question 5
5(a) Candidates needed to identify the outlier and show how its omission or inclusion could lead to two different results in order to gain marks for this question.

5(b) This was a challenging question with the majority of candidates providing just observations and not conclusions about the data.

5(c) It was encouraging to see very detailed descriptions of the stages in the nitrogen cycle in the majority of student responses.

Question 6
6(a)(i) Most candidates could label the axis correctly and draw a line to describe the relationship between number of mutations and distance from the nuclear power station.

6(a)(ii) The majority of the candidates found it challenging to identify the causal mechanism and give an example of further evidence required.

6(b) The best responses recognised the Matt's idea was linked to mutated genes being passed on. Few candidates linked Claire's answer to background radiation.

Question 7
7(a) The best responses could define sustainability clearly and succinctly.

7(b) Most candidates could give the three best factors which need consideration when producing shopping bags sustainably.

7(c) Many Candidates were not secure in selecting the best explanation for why we should reduce the use of biodegradable bags.

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

General Comments:

Candidates have become significantly better at following command words and giving the correct number of responses required in each question. There were only a very limited number of instances where additional responses were given, such as 2 items circled instead of just 1.

The level of response questions were generally well responded to with very few omissions. The way candidates approach these styles of questions have improved greatly in recent years.

The timing of the paper seemed appropriate with candidates regularly completing all aspects of the paper. The overall attainment of the candidates seems to have improved from previous sessions.

Candidates who need more space for their answer are recommended to use any extra space available on a page before going to a supplementary answer book.

Comments on Individual Questions:

Question 1
1(a) This question was very well answered, with almost all of candidates identifying at least 1 material that is made of living things. Where candidates selected an incorrect response, it was often polythene.

1(b) Most Candidates could recognise that there are just 2 elements in a hydrocarbon.

1(c) Candidates could identify that copper was a pure substance and that crude oil was a mixture. The difficulty came with deciding on sodium chloride. Unfortunately, only a small number of candidates could recall that sodium chloride is a pure chemical.

Question 2
2(a)(i) A large number of candidates could correctly identify the diagram representing carbon dioxide.

2(a)(ii) Again a large number of candidates could correctly identify the carbon monoxide as the substance that is formed when there is a limited supply of oxygen for combustion.

2(b) Most candidates could give a different source of pollution to support Tanya's ideas. The most common responses included 'cars' or 'vehicles'. Fewer candidates were able to explain that as more coal was burned, the amount of pollution increased. Many simply repeated the ideas put forward by Joe. Very few candidates could go on to explain that the relationship between the amount of coal burned and pollution was a positive correlation.

2(c)(i) The majority of candidates could identify the true and false statements in the table.

2(c)(ii) This question proved difficult for some candidates. Where working out had been included in the response but the final answer was incorrect, there were errors in addition and the lack of division by six.

2(c)(iii) A significant number of candidates omitted this question. This could have been because the question was not directly underneath the graph and so was simply missed. For the candidates that did attempt this question, the success rate was high. The 'error carried forward' from the calculation of the mean did not impede candidates unless they had simply added their values together. This meant that the scale in the graph could not accommodate their bars.

Question 3

3(a) This was generally answered well, but the common misconception was that 'carbon dioxide' had the largest percentage abundance with 78%. This could be attributed to the fact that the consequences of pollution by carbon dioxide is considered in detail. Perhaps the actual percentage abundance of carbon dioxide can be emphasised in centres for future exam sessions. The percentage abundance of Argon in the air varied and included values that added up to more than 100% in total.

3(b) A significant number of candidates struggled with this question. The description of the changes to the atmospheres that were given in the table were not forthcoming in many responses. Candidates were able to use the information provided to comment on the changes in gases, particularly on Earth. Of those who were unsuccessful with this question, it was often because they discussed issues such as global warming, climate change and the effects of human activity on a modern Earth, but made no reference to the data provided. Photosynthesis and dissolving in the oceans were often identified as reasons for the decrease in carbon dioxide levels on Earth. The cooling of the Earth to form the oceans, removing water vapour, was discussed to a lesser extent. The quality of written communication was poor in some areas, particularly organisation of ideas. For example, it was often unclear through either poor grammar or a complete omission of a word, which planet the candidates were referring to. 'The atmosphere has decreased on Earth and increased on Mars' or 'the carbon dioxide went up' were typical responses that failed to score as candidates missed crucial marks to show they understood the data in the table.

Question 4

4(a) This question was generally well answered.

4(b)(i) A significant number of candidates correctly calculated that 26 and 14 added together equalled 40. Where incorrect responses were given, the common error was 10 (the number of rejected balls). Other common incorrect answers were 26 and 14.

4(b)(ii) An encouraging number of candidates scored both marks in this question. The 'error carried forward' here gave several candidates the reprieve needed from their responses to the previous question. The formula being given directly in the question could have helped the candidates follow the calculation through to completion. Evidence of candidates substituting numbers onto the formula in the box supported this view and were evident on a number of occasions.

4(b)(iii) This question was generally well answered. The reasons why we repeat experiments still seems to bring up the idea of 'fair testing'. Centres need to move away from this as a response and move towards the terms of accuracy, repeatability and reproducibility.

4(c) A significant number of candidates scored this mark. Misconceptions were centred around the distractor of 'refining' as this was the most common incorrect response given.

4(d)(i) Again a significant number of candidates scored this mark and correctly identified that diagram A represented the cross linking.

4(d)(ii) The majority of candidates scored at least one mark in this question. Usually 'harder' was the easier word to select to complete the first of the sentences describing cross linking. The plasticiser sentence appeared more challenging with a number of candidates choosing 'much stronger' where they selected an incorrect response.

Question 5

5(a) Responses to this question showed a lack of understanding of the properties that might be needed from a sailing rope. A large number of candidates identified the incorrect fibre. All fibres were regularly selected and for a variety of reasons. Where this was the case few candidates could link the properties to the purpose for their choice, or even why they were chosen over the other fibres. The idea of 'comparison' was often overlooked. Some candidates struggled to relate the words used to describe the fibres in the stem of the question and the words used in the table, such as strong, light, flexibility with stiffness, density, tensile strength, water absorbency and the ability to float or sink. There were however, many good responses in this question, the best responses being those where candidates had processed the data, explained the properties **and** compared the properties with other materials. For example, good candidates showed that they understood a low number for stiffness equated a high flexibility, and low density was desirable because it made the rope lighter. Marks were most commonly lost when candidates merely restated the stem of the question, choosing a material and stating that it was light and flexible. In some instances, candidates incorrectly interpreted the data and assumed that the high values were always the best.

5(b) A significant number of candidates scored at least one mark in this question. The most common of the correct responses was 'buying rope from other countries is expensive'. The second correct response was identified to a lesser extent.

Question 6

6(a)(i) Most candidates could give the correct response of '30' for the death from Typhoid in the year of 1890 but less were able to give the total number of deaths from Typhoid in 1930 as this required a calculation. Often, the answer put here was 5, thus indicating that the candidate had used the graph instead of inferring from the table that the population in the city was 200 000 and therefore requiring them to double their answer.

6(a)(ii) Many responses scored the mark for stating that the number of deaths from typhoid decreases. Most of these responses also gained a second mark for either saying that the deaths went down to zero in 1950 or there was a major decrease after 1910.

6(b) This question was generally well answered with the majority of responses scoring four marks or higher. Candidates were able to interpret the data, and explained how it showed that the use of chlorine was effective, and also how the chlorine killed bacteria in water. They gave dates and explained the differences before and after 1910. Weaker candidates became distracted with irrelevant information, such as harmful effects of chlorine, or ignored the effect of chlorine altogether. The general pattern of many answers was: 'Zac is correct, deaths lower after chlorination of 1910' often with a statement about the action of chlorine. Some candidates used poor language skills as they spoke of the chlorine 'getting rid of germs that caused typhoid' rather that the action of the bacteria being killed by the chlorine. Some candidates confused Beth's comment and argued solely for her, commenting that chlorination of water could be dangerous, with some mentioning the formation of THMs and the link to cancer. A lot of candidates seemed to think that this answer required a balanced view, stating that Beth was 'kind of right', yet failing to challenge the 'chlorine has no effect' comment. Other candidates that chose Beth as correct only referred to the first part of her comment ('the deaths from typhoid fell before chlorine was added') and again, failed to acknowledge the 'chlorine has no effect' comment.

Question 7
7(a)(i) A significant number of candidates could identify cereal D as the cereal that had changed from medium to low.

7(a)(ii) A large number of students correctly selected cereal C.

7(b)(i) The majority of candidates could identify 'Carlos' as the person speaking about correlation.

7(b)(ii) The majority of candidates could identify 'Ben' as the person speaking about risk and benefit.

7(c) This question was less well answered and with no discernible trend in incorrect responses.

Question 8
8(a) This question tried to identify the candidates understanding of the method of transportation of harmful chemicals into the food chain and then the consequential effects. Candidates were drawn to talk about health risks and problems such as asthma, lung disease, cancer and heart problems rather than how the issues arise or build up in the food chain.

8(b) Candidates struggled with this question and were often distracted into discussing the planet mercury rather than the poisonous metal. Candidates often spoke about the people not knowing the risks, despite being told in the stem of the question that people knew the metal was harmful.

A171/02 – Twenty First Century 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.

There were some very good responses to the 6 mark questions this year, though some candidates would have gained by planning their answers to these before writing. Almost all candidates showed very good knowledge and understanding when asked to process data. However, they found evaluating and drawing conclusions from data much more difficult. Candidates should be given plenty of opportunity to develop these skills throughout the course.

Candidates need to be specific in their written answers. There was a tendency for candidates merely to repeat the stem of the question which did not gain marks. There were also vague references to the environment or substances being harmful in answers. Such statements rarely score.

Almost all candidates made good use of their time and the number of no response answers was very small. Again, there were a few candidates who struggled to respond to the higher level questions. They would have been better suited to the foundation tier paper.

Candidates who need more space for their answer are recommended to use any extra space available on a page before going to a supplementary answer book.

Comments on Individual Questions:

Question 1
1(a) Most of this question was a common question with the foundation tier and proved to be a straightforward start to the paper. Almost all scored in part i, and in part ii higher candidates had no problem working out the mean of a set of data. Most gained two marks in part iii by correctly completing the chart. Part iv proved more difficult. Candidates need to take care not to repeat the question eg ‘the pollution is increasing. It is important that they use the data to explain the points made. Many did pick up on the short time period though some were vague stating ‘not enough tests had been done’ rather than focussing on the number of days.

1(b) This was a discriminating question with good candidates able to pick out the correct statements to explain the formation of solid carbon particles when coal burns.

Question 2
For many candidates the answer was very confused and they need to be guided to take a moment to plan their answer to these 6 mark questions. Rather than start with a gas and describe the change on each planet, or vice versa, the answers would meander through planets and gases with no really structure. As a result of this many candidates missed marks because they simply didn’t give a full answer, probably without realising it. However, marks were gained by good descriptions of the role of cooling temperatures and photosynthesis, in changes to the atmosphere on Earth. A significant number of candidates gave pollution and other effects caused by man as reasons for the changes to the Earth's atmosphere. These candidates usually then said that Mars' atmosphere had not changed as much as there is no pollution on Mars.

Question 3
3(a) Many candidates are still not clear about the formation of nitrogen dioxide in car engines. Some did not realise that high temperatures are needed for the reaction to occur and many thought that the nitrogen atoms come from the fuel.

3(b) They were also unclear what happens to nitrogen dioxide once it is in the air. All wrong answers were seen though the most common was that it is oxidised to nitrogen in catalytic converters.

Question 4
4(a) A very well answered question, with almost all correctly picking out that changing the surface affects the outcome.

4(b) In part (i) few candidates got this entirely correct, but most got 1 mark for finding the number of competition balls in the data. Those who did not score often failed to show the working to their answer. Part ii was well answered.

4(c) Understanding of how modifications affect the properties of polymers was weak with few candidates gaining marks. Weak candidates guessed answers randomly and some good candidates lacked the confidence to go with one statement per line: correct answers were crossed out so that an incorrect mix of statements was given.

Question 5
5(a) Many answered this well, but those who failed to pick up marks, or didn't achieve beyond level 1, had problems with knowing the significance of the properties - stiffness; density; and water absorbency. They saw high readings as a positive and Kevlar was often picked out as the best type of rope. Also candidates again need to take care that they do not merely repeat the question eg by saying 'polypropene because it's flexible and light', but show that they understand, and can interpret, the data.

5(b) This question was not well answered. Most gave a poorly stated argument based on relative availability. Others, who did not gain marks, wrote about the environmental impact of synthetic materials and biodegradability of natural fibres. There were also many attempts to write about the properties of the materials, rather than the issues of making ropes out of these materials.

6(a) This question about the boiling points of different compounds of crude oil was discriminating.

6(b) This question asked for two uses and it is important, when answering, that these are distinct and different. Giving two uses that are both fuels can only score 1 mark. Sometimes candidates would just write ‘plastics’, as if plastics were fractions, rather than indicating that fractions were used to make plastics.

6(c) Most candidates could recognise a balanced diagram for the splitting of pentane.

Question 7
7(a) There were some excellent answers to this question on why people should eat less salt and almost all candidates gained at least one mark.

7(b) In part (i) many candidates simply stated that they agreed with the FSA without using the data and showing any form of calculation. A few that did show the calculations stated that the FSA were wrong because the figures were not exactly 50%; which was missing the FSA’s point. In part ii many gained a mark for suggesting more cereals should be tested but the second marking point was rarely seen. Instead, many incorrectly suggested using samples of more than 100g, or using years other than those given.

7(c) Candidates found the calculation in part i difficult with all the wrong answers given equally. In part ii the main reply was that of risks not yet known. Few picked up on any health benefit as they did not seem to realise that less salt would be needed to get the same taste in our food. A significant number of candidates got this completely wrong and suggested that the risk of heart disease/high blood pressure would be 2000 times greater using nanoparticle salt as it is 2000 'saltier' than regular salt.

8(a) Answers to this question showed limited understanding of the topic. Many responses referred to continental drift; fossil evidence, the splitting up of Pangea and phrases taken from question 8b. Magnetism was often not referred to at all, and when it was, it was limited to magnetic pole flipping and magnetic stripes. Some candidates thought that the magnetic field of the Earth was responsible for the movement of Antarctica, describing an attraction between the land mass and the South pole. Some wrote at length about the magnetic field of the Earth, without stating that this produced a directional effect of magnetism in the rocks, as they formed.

8(b) This part of the question proved much more straightforward to candidates. Most were able to pick out why continents are able to move over the surface of the Earth.

Question 9

9(a) Some good answers were seen with air or water pollution as a common scoring point though candidates also used ideas about food chains and bioaccumulation.

9(b) Many scored one mark by explaining there was no alternative, at the time, to using mercury. It was rarer to see any of the other marking points. Some candidates made the point that people didn’t think that mercury was harmful, even though the question said they did know.

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

General Comments:

Candidates were able to show that they had engaged with the course and used their knowledge effectively to answer the questions. Most candidates seemed to have enough time to attempt to answer all the questions they could do. They performed well on short answer and tick box questions, but many were unable to apply their knowledge to new situations.

Candidates were able to do the basic mathematics calculations required. From the calculations that were written out it was clear that some did not have a calculator available to them. In the six-mark extended-writing questions, some candidates only answered part of the question and this restricted the marks they were able to achieve on those questions.

Comments on Individual Questions:

Question 1
This question was well answered. The most common mistake was to say that the Sun produced energy by fusing carbon. Some candidates thought that the Sun was a planet.

Question 2
2(a) A common error was to tick the factually correct choice 'The Earth's crust is made of tectonic plates'.

2(b) Similarly, 'Different continents have exactly the same rocks' was a common incorrect answer for this question.

3(a)(i) Most candidates correctly read the speed of the tsunami from the table.

3(a)(ii) Candidates who were able to calculate the speed generally forgot to divide by 1000 to convert their answer to kilometres.

3(b) Candidates did not know the meaning of directly proportional. Many were able to state that as one quantity increased the other also increased and many others assumed that it meant the two values were the same. Parts b) and c) were on both the higher and foundation paper, and were some of the more difficult questions on the foundation paper.

3(c) Candidates often gave their answers in terms of 'bigger waves' and it was not possible to credit this as they had not explained whether they were referring to the wavelength or to the amplitude. Those that did use the correct terms generally scored marks. There was a misconception that the frequency would change, presumably because the wavelength had changed. Candidates did not realise the significance of the earlier part of the question – i.e. that the speed had also changed. Other candidates wrote that, 'The wave speeds up as it approaches land.' Several candidates tried to answer in terms of P and S waves.

Question 4
It was disappointing not to see more diagrams of the solar systems with the orbits shown. A large number of candidates sensibly used the data they were given to draw 5, or sometimes more, planets and a larger central star. Some did not write anything about the formation – most of the marks awarded were given for the drawing. A few candidates did describe the formation of stars and the formation of planets. Applying what they knew to an unfamiliar situation caused problems for many. Some candidates did not attempt the question and others wrote that they had not learned about Tau-Ceti. There were a number of answers indicating that Tau-Ceti was formed, like the Sun, by the Big Bang.

Question 5
5(a) The digital signal was more often correct here. Some candidates did not use the information given but wrote about advantages and disadvantages as differences.

5(b) Generally candidates who used 0s and 1s got this correct but it was common to see the numbers 0,1,2,3,4,5 written in the boxes.

5(c) Many candidates successfully gave an answer about clarity, noise, or, more rarely, signal quality. Fewer gave a creditworthy second advantage. There were vague answers about better or stronger signals.

Question 6
6(a)(i) This was very well answered, showing candidates had practiced graph work and data analysis. However, some candidates must be more careful when copying information; sometimes 200 was given instead of 2000.

6(b)(i) and **(ii)** These were well answered. Where candidates scored only one correct answer there was no one name that was commonly incorrect.

Question 7
Most candidates were able to state that people would worry about the harm to their bodies. Better answers specified the head or brain. A few seemed more worried about the damage to the phone. Some candidates thought the egg was cooking because the phones were hot, so this would cause damage to hands and pockets. It was good to see able candidates giving sensible reasons for doubting the journalists – often in terms of lack of evidence and scientific testing. A few candidates wrote statements like 'Just imagine what it would do to a person' which sadly, did not answer the question.

Question 8
8(a)(i) Most candidates read the maximum power correctly, a few gave 1.8kW

8(a)(ii) Many candidates did not realise they needed to use the graph to find the power. They thought that 7.5 m/s must feature in the calculation. It was common to see 24 x 7.5 = 180.

8(b) Many candidates said something about generating more power, or about needing more power for heating. There were a number who seemed not to understand the term wind farm. They thought that wind farms grew crops, or that the farmer could use the electricity to keep the animals warm. Some candidates thought that the electricity made in the winter could be stored to use in the summer.

8(c) This was answered well. Candidates must take care to follow instructions; as all the boxes needed completing.

Question 9
9(a) Lots of correct answers. Those candidates who slipped up in calculating the energy often still scored for totalling the values correctly.

9(b) Most candidates correctly chose 90p here.

9(c) This was quite varied with wrong answers spread among the possible options, but 'The oven and kettle are connected to a higher voltage' was the most common incorrect answer.

Question 10

Candidates often gave the advantage of gas to be that the power stations produce a lot of energy, but this is not generally true when compared with nuclear power stations. Some candidates grouped both stations together to give the advantages and disadvantages of both (presumably when compared to renewable options). Better responses mentioned carbon dioxide and/or global warming. 'Air pollution' was a weaker answer often seen, and some other weak answers simply cited 'pollution'. A lot of candidates thought that nuclear was a renewable option, that nuclear power stations are cheap to build but expensive to run, and gas power stations are safer.

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

General Comments:

This is the second examination series in which all physics and science candidates entered their examinations at the end of the course, and the candidates' performance this year was similar to that of last year.

Few candidates seemed to have been short of time, and examiners commented that the majority tackled the questions well in extended-writing but that the mathematical aspects were less well done. Answers were generally clearly and logically presented but there were a number (some high-scoring) which were very difficult to decipher and may well have lost marks from this.

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.

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

(i) Many candidates find it hard to express themselves clearly in English. This is obviously a feature of the 6-mark questions, but other questions (such as 2b, 2c, 5b and 12a) also require the candidate to communicate his or her ideas to the examiner. There is no need to use elaborate English: simple, short sentences will do very well, and bullet-points are often a good way of organising one's ideas.

(ii) Mathematical skills are an important aspect of GCSE Science/Physics, and will continue to be so in the revised GCSE. Many candidates found the organisation of calculations very difficult, and this is made more noticeable when standard form or the conversion between units, e.g. between kW and MW, is involved. It is clear that the majority of candidates, in question 2(b), believed that 'the speed is directly proportional to the depth' meant 'as the depth does up, so does the speed' which is not enough for credit as the mathematics skills (listed in Appendix C in the specification) include 'understand and use direction proportion and simple ratios.' Examiners did point out, however, that candidates who laid out their working in a methodical, clear way would often rescue marks from an incorrect answer as they had shown that they had covered some necessary stages of the calculation correctly.

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 higher level 2 or a level 3 mark. Diagrams of the planetary system (often labelled as if it were our solar system) were usually good, but the orbits were often not clearly shown and sometimes there were two or more planets following the same orbit. The best candidates did answer the question as written ('...describe how the different parts may have been formed') but there was much confusion with the Big Bang.

Question 2
2(a)(i) Candidates were required to convert the given time into seconds, calculate the distance travelled at 180 m/s in the time they had deduced, and then convert the answer into km. Few managed all three steps with no errors, and the commonest mark awarded was the second one, with 'error-carried forward', i.e. getting the wrong time but then correctly using that value to find a distance, which was often then not converted from m to km.

2(a)(ii) About half the candidates could estimate a depth which required a simple interpolation between two values in the table. Unsuccessful candidates here went for the greatest possible depth, or averaged the six values in the table.

2(b) Very, very few candidates could explain what direct proportion meant or demonstrate that the given data did not display it.

2(c) Candidates who applied the appropriate terminology of wavelength and amplitude to the diagrams usually earned both marks, but weaker responses referred to 'bigger waves' or 'more powerful waves' in a vague way.

Question 3
3(a) Most candidates scored 2/3 marks when answering this question. Some candidates missed the fact that the third observation was not enough to support Wegener.

3(b) This question required both correct boxes for the mark, and the two other facts given were both correct, but irrelevant here: over half the candidates were able to answer this question correctly.

Question 4
4(a) This question was also on the foundation tier, and was completed correctly by most candidates

4(b) Less than one-third showed understanding that all chemical elements with atoms heavier than helium were made in stars.

Question 5
5(a) This question was common with the foundation tier paper, and most candidates scored very highly.

5(b) This part was more demanding than part (a), and many candidates clearly did not read 'State and explain **two other changes** (i.e. other than flooding) that could result from global warming.' There were a number of vague pre-prepared answers about global warming (including the inevitable references to the ozone layer) which did not address the question but gave generalised answers vaguely related to global warming issues, such as how to reduce carbon emissions

Question 6
Roughly half of the candidates referred to noise in mark in (a), with about a quarter of those getting the second mark for stating that digital signals could be stored or processed by computers. The objective part (b) was surprisingly poorly answered, quite possibly because candidates found it hard to put ticks in almost all of the boxes.

Question 7
This extended response 6-mark question was well answered in general: very few candidates failed to give advantages and disadvantages associated with the use of mobile phones. Level 3 responses to this question required demonstration of the fact that microwave radiation was non-ionising, that microwaves were able to heat tissues and (very rarely seen) the fact that the brains and skulls of children are still developing, so may well be more susceptible to damage. Better answers spelled out the fact that there is no agreement that the use of mobile phones is risk-free, but that there is as yet no proof that any risk exists. Weaker answers postulated that the radiation may be radioactive, or cause mutations, or over-heat the brain of the user. A popular postulated risk was the social one of grooming or bullying through email or social networks: these responses were accepted.

Question 8
The strongest candidates typically obtained two of the three marks in this multi-stage calculation, typically making an error in one stage. Weaker candidates tended not even to attempt the question.

Question 9
This was an objective question, so few left it blank, but relatively few candidates got all three parts right. Part **(a)**, requiring the candidates to calculate power and then convert from watts to kilowatts, was the least well done while part **(b)**, which asked candidates to scale up the energy from that for a 1°C rise to an 80°C rise, was done well by most. It was surprising, in part **(c)**, how many candidates expected the kettle to boil in 0.4 seconds, or were happy that it would take over an hour to boil.

Question 10
10(a) This question was well answered.

10(b) Relatively few candidates labelled the boxes to name the parts of the system, instead they described the process. Provided that the candidates description involved a turbine, followed by a generator and then a transformer, even in the same box, credit was given. A large number did not read 'hydroelectric power station' and including a boiler, or a description of its function, in the system.

Question 11
This was the most demanding extended response 6-mark question on the paper, and over half the candidates restricted the marks available to a maximum of 2 by failing to make any reference to the efficiency graph. As the question stem provided a graph, a map and a bar chart, candidates should expect to have to extract information from all three.

The question stem stated that a factor to consider was the distance from the wind farm site to the consumers. Candidates read this in two different ways: that transporting energy over a greater distance involved greater energy losses, or that having a wind farm close to where many people live was unsightly and a source of noise pollution. Both arguments were acceptable. The best answers compared summer and winter performance at the different sites and deduced that a wind farm at Paisley would produce little if any power whereas Kirkwall would be the most productive, often choosing Kinloss as a compromise between efficiency and distance.

Question 12
12(a) This question was intended to allow candidates to compare the relative risks of radioactive waste in the fly-ash from coal-burning power stations and the nuclear waste from nuclear power stations. Marks here tended to be earned from the generic marks explaining why radioactive materials introduce risk, and also from the fact that coal-burning power stations produce carbon dioxide, a green house gas (this had to be allowed as a legitimate answer as the question asked for 'the different problems associated with the waste' not '…with the radioactive waste'). A surprisingly large number made no reference to the first sentence in the stem and stated 'coal-burning power stations do not produce radioactive waste.'

12(b) The calculation in this question had a high omit rate; this is probably due to a combination of two factors – it involved a multi-stage calculation and it is the last question in the paper. As in questions 2(a)(i) and 8, candidates who laid out their work systematically had a better chance of getting marks as it was clear which stages of the process they had managed correctly. A large number omitted to scale up for 24 hours, or to scale up for 1200 MW – each of these approaches, if done correctly in other aspects, gained 2 of the 3 marks.

A144 – Controlled Assessment

General Comments:

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

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. A minority, however, had clearly dispatched samples after half-term having received requests for samples in good time.

A large number of arithmetical errors and clerical errors was once again noted.

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 also 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 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.

It was noted yet again 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. This was also usually counter-productive as candidates had more opportunities to contradict themselves, and in over-elaboration often introduced some erroneous science. 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 2015 was:
-Antibiotics
-Carbon – catch it if you can
-Nuclear power

The evidence suggests that Antibiotics and Nuclear power were equally popular with Centres. Candidates at fewer Centres attempted the Carbon – catch it if you can task. The Antibiotics Case Study generated scripts with the science of most variable quality. For this task, some candidates did choose interesting questions, for instance related to specific bacteria or diseases, but then reverted to more generic evidence. For the Nuclear Power topic, many candidates discussed renewables when these were not necessarily pertinent to the question under discussion.

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 in this report. 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.

- **Antibiotics:** antibiotics and how these work (simply) against bacteria, classes of antibiotics, the importance of taking the full course of antibiotics and antimicrobial resistance, as appropriate to the question posed.
- **Carbon – catch it if you can:** the requirement of carbon capture and storage (CCS) in terms of addition of carbon dioxide to the atmosphere and its effects, points at which carbon can be captured, types of carbon capture and the underlying chemistry, as appropriate to the question posed.
- **Nuclear power:** the chemistry behind generation of nuclear power (an overview, as nuclear fission is an Additional Science topic), generation of electricity from nuclear fuel, types of nuclear waste and its management, dangers of ionising radiation, alternative methods of generating electricity, 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. 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. 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 Antibiotics Case Study was often rather generic in nature, when data pertaining to the questions was 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.

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

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). 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.

This 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. 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'. This session, this was usually the case. The recommendations made based on candidates' conclusions were often vague, somewhat generic, or even absent, 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, or often conclusions and recommendations could not be distinguished owing to the nature of the question. 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 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. This was often a focus of candidates' attention, however, to the detriment of discussion in the 5-6 mark band.

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 2015, these were:

- **Microorganisms and temperature**
  The hypothesis: The temperature affects the reproduction of microorganisms.

- **The hottest flame**
  The hypothesis: The heat energy from a Bunsen burner flame depends on the size of the air hole.

- **The efficiency of a heating element**
- **The hypothesis:** The amount of water affects the efficiency of a heating element.

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 some Centres, in The Efficiency of a heating element task, candidates simply measured the rise in temperature of different volumes of water, which in the format carried out, did not truly test the hypothesis. This affected the award of marks in Strand G, and in Strand D at the 7-8 mark level.

Candidates in many Centres derived a prediction from the hypothesis provided; there is no 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 Hottest flame experiment was carried out by the vast majority of candidates. Candidates at only a handful of Centres attempted the Microorganisms and temperature task.

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, sometimes to very good effect. This session, the terms ‘confounding variables’ and ‘extraneous variables’ had crept into the write-ups of candidates of a number of Centres. Candidates clearly struggled with the appropriate use of these concepts, so any use of these terms is advised with a good deal of caution.

Candidates 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 the method used must be appropriate to generate data ‘of generally good quality’. 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 of four 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. At the 7-8 level, for The hottest flame Practical Data Analysis, some scientific explanation/justification of the fact that water *temperature* was being measured when the hypothesis referred to heat *energy* from a Bunsen burner, would have been expected.

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). 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'.

Main points *specific* to each task:
Microorganisms and temperature:

- culture of yeasts is a low-hazard activity, but candidates should avoid spillages and/or aerosol formation
- malt agar is used for the cultivation of yeast and other fungi. Its low pH (5.5 ± 0.2 at 25°C) is optimal for fungal growth and will inhibit the growth of bacteria
- if using bacteria (or yeast), for 7-8 marks, the Risk Assessment should be specific to the microorganism used
- candidates should follow good hygiene practice when handling any microorganisms
- hazards associated with the use of water baths or incubators, i.e. electrical equipment; portable appliance testing (PAT)

The hottest flame:

- hazards and risks from hot Bunsen burners, tripods and gauzes, i.e. a hot object or flame, and burning
- hazards and risks from hot water (scalding). Note that the final temperature of water may not have been sufficiently high to cause scalding, but when preparing Risk Assessments, this may not have been apparent (unless final temperatures were specified, or preliminary work would not have indicated this). An acknowledgement of the fact that the temperature rise of the water may not be enough to result in scalding could have been one way of addressing the 'appropriateness' of the Risk Assessment in the top mark band.
- candidates *might* consider the accumulation of carbon monoxide, and recommend adequate ventilation
- possible issues with soot/allergies.

The efficiency of a heating element:

- hazards and risks from a hot heating element or kettle, i.e. a hot object and burning
- hazards and risks from hot water (scalding). Depending on how the experiment was carried out, the final temperature of water may not have been sufficiently high to cause scalding, but when preparing Risk Assessments, this may not have been apparent (unless final temperatures were specified, e.g. boiling point, or preliminary work would not have indicated this). An acknowledgement of the fact that the temperature rise of the water may not be enough to result in scalding could have been one way of addressing the 'appropriateness' of the Risk Assessment in the top mark band.
- Portable Appliance Testing (PAT) of electrical equipment, i.e. the kettle or heating element

- spillage of water, and electrical equipment (where appropriate)

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. 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 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 2014, 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. For The hottest flame, many candidates did not begin their x-axis of their graphs at zero or zero percent, failing to realise that this was equivalent to the air hole being fully closed and therefore beginning the axis at a negative value. While some benefit of doubt could have been given here, many of these candidates then extended their lines of best fit into this area, effectively to a negative value of air hole aperture, which is unequivocally 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 also clear evidence that some Centres do not check candidates' plotting of points carefully before awarding marks. Graphs drawn without appropriate scales, incorrectly plotted points and poorly-drawn lines of best fit, were on numerous occasions, incorrectly, awarded high marks.

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. Candidates should add points or crosses with sharpened pencils, and not use ink. 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. 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.

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 or large-squared 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 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. This strand 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.

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 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. 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 *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. For the 2015 tasks, the relevant science should have included:

- **Microorganisms and temperature**
  At **3-4 marks**, many candidates related the trend in data to basic science, with an increase in temperature leading to increasing growth and/or reproduction of the microorganism, and depending on the temperature range investigated, the yeast being killed at higher temperatures.
- 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). Candidates added that the growth rate and hence the reproduction rate are faster with increased temperature, leading to increased population growth at higher temperatures.

  Some candidates linked this with enzyme activity and anabolic reactions, but this could not be insisted on as candidates are not introduced to these concepts until B4.

- **The hottest flame**
  At **3-4 marks**, many candidates described the basic trend and used ideas about complete and incomplete combustion (though not necessarily the terms themselves) with reference to more/less air when the air hole is open/closed to explain this. They related this to more/less energy being released for the full four marks (or words to that effect).
- 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), and referred to complete/incomplete combustion because of the availability of oxygen. At this level, candidates were expected to use word/symbol equations for the combustion of methane; and possibly the formation of carbon monoxide and carbon. Some suggested that there will be energy remaining in the products of incomplete combustion.

The efficiency of a heating element

- At **3-4 marks**, many candidates related the trend in data to basic science. Here, we were looking for use of one of the formulae from the specification, most likely the calculation of energy transferred. References to heat transfer, which are Key Stage 3 concepts, i.e. radiation, convection and conduction, were also acceptable at this level.
- At **5-6 marks**, many candidates should explain 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).

  The science at this level came from the calculations required, including calculations of efficiency.

  If efficiency was not referred to or discussed, the mark for science was limited to four, though this sometimes extended to five for a good description of the trend and sound Quality of Written Communication.

  Some candidates appreciated that surface area to volume ratio of the water in the vessel decreases with increasing volume, so the area over which heat is lost decreases in relation to volume. They suggested that the efficiency of heating the water therefore increases as the volume increases.

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 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 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. For The hottest flame, for instance, some candidates suggested testing the hypothesis for a propane burner rather than using methane.

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: *Michelle Hawley, Science Subject Specialist, OCR, Education and Learning, 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 these are required, and you wish to, before submitting marks for moderation in May.

Appendix I: Judging a source of information

	The further to the right of the table, the more reliable the source is likely to be				
1 Publication / source	Website or newsletter of a private individual, 'blog' or forum entry from unknown writer.	'Respectable' pressure group web-site or newsletter.	'Quality' media, e.g. the BBC, The Guardian.	School textbook or science magazine, e.g. New Scientist, Focus, Catalyst.	Peer-reviewed journal or government report on a scientific area.
2 Status of the author	Individual of unknown background, or known extremist.	Science student or well-informed person.	Teacher/professional scientist with expertise in a different field.	Scientist working in this field.	Recognised expert in the field.
3 Author's affiliation or institution	Non-science related.	Representing a particular view only (e.g. manufacturer or pressure group).	Independent, science-related source.	University, medical school, science institute.	Leading research centre/major company/government research centre.
4 Nature of the data presented	Little or no data given.	Data of doubtful reliability, e.g. based on flawed procedure or small or unrepresentative sample.	Based on a single study, or little information about sample design or procedures.	Clear indication of valid design e.g. use of accepted Standard Procedures, large samples, extended periods of study.	Different studies give matching results.
5 Science explanations	No explanation or data to support a claim.	Explanation not yet tested or confirmed.	Claim appropriate but can have other possible explanations.	Agreed by most of the scientific community.	Fully agreed by almost everyone.

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

Use Rows 1-3 for Strand A(b)

Use all rows for Strand C(a)

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

for example,
for instance
such as
as shown by
as demonstrated by
in the case of

Adding to

and
also
as well as
in addition
moreover
what is more

Comparing

(similarities)
compared to
similarly
likewise
in the same way
equally
as with

Cause and effect

because/as
as a result
so
therefore
since
consequently
thus

Emphasising

in particular
significantly
more/most importantly
notably
especially
indeed

Comparing

(differences)
compared with
however
but
in contrast
on the other hand
whereas
alternatively
instead
nevertheless
despite this
in spite of
even so
otherwise

Sequencing

firstly/secondly...
initially
finally
subsequently
after/afterwards
meanwhile
eventually

Qualifying/Restricting

although
except
yet
apart from
however
unless
only if

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