Oxford Cambridge and RSA

GCSE

Physics A

Twenty First Century Science Suite

General Certificate of Secondary Education **J245**

OCR Report to Centres June 2014

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

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

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

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

General Comments:

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

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

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

Comments on Individual Questions:

Q1(a)(i) Most candidates ticked the correct box. These candidates were not distracted by ‘Smaller planets are more distant from the Sun.’

Q1(a)(ii) Many candidates gave an acceptable estimated value. Some could explain how they had arrived at their estimate. Good responses used the data for both Earth and Jupiter.

Q1(b) This was consistently well answered. Good responses correctly differentiated between ‘comets’ and ‘asteroids’

Q2(a)(i) Almost all candidates ticked at least one correct box and most ticked two.

Q2(a)(ii) Many candidates wrote answers that differentiated between the P waves and the S waves. Some candidates knew that one type of wave stopped while the other carried on, and some knew that it was the S waves that stopped (or the P waves that continued). Candidates needed to understand that the diagram was incomplete and did not show that both waves stopped.

Q2(b)(i) Some candidates scored for this question, aimed at higher ability candidates. To get the marks for this question, candidates needed to state the time delay and then multiply their delay by 8 km/s. Showing their working sometimes scored a mark in case of error.

Q2(b)(ii) Candidates needed to write down a calculation that showed the rule worked at 2000 km for 1 mark, or write down a calculation that showed the rule did not work at 4000 km for 1 mark. Both of these calculations scored 2 marks.

Q3 Good responses addressed both parts of this six-mark extended writing question to achieve level 3. For the telescope improvement, candidates needed to mention an improvement such as better lenses, computer tracking, putting telescopes on top of mountains or reducing atmospheric interference. In the question, 'telescopes on Earth' hinted at using space telescopes, or the Hubble telescope.

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

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

Q4(a) Many candidates scored at least 2 marks for identifying which statements about photons and radiation were false and which were true.

Q4(b) This question proved to be too difficult for candidates. They needed to remember and use the fact that intensity = photon energy x number of photons. It appeared that most thought they were being asked to extract information from the table.

Q5(a) To get marks for this questions candidates needed to state that 'the ozone protects us by absorbing the radiation'. Some candidates knew the correct scientific words 'ozone' and 'absorb'.

Q5(b) Most candidates were able to give a method of protection against ultraviolet radiation. Some explained how their method worked, for example by absorbing radiation or reducing exposure.

Q6 Most candidates understood that the radiation, whatever it was, was safely contained inside the oven. Many candidates knew that microwave ovens use microwaves not gamma rays.

Q7 In answer to this six-mark extended writing question, it was pleasing to see that the majority explained how the graphs showed a correlation and achieved at least level 2. For level 3, some correctly identified the mechanism as the carbon dioxide in the atmosphere.

Q8(a) The majority of candidates ringed the correct response.

Q8(b) Many candidates scored for saying that computers allowed you to edit the images. For a second mark some candidates suggested the ease of transferring or sharing images.

Q9(a) It was pleasing to see that most candidates knew that coal burning power stations produce greenhouse gases.

Q9(b) It was pleasing to see this question so well answered by the majority. Some candidates needed to understand that 'in each power station, total energy input = total energy output'.

Q10(a) Many candidates successfully found the difference between the two readings. To get the mark here candidates need to understand that this is the same meter at 2 different times and a difference is needed, not a sum or a product.

Q10(b) The large majority of candidates explained that summers were hotter and/or lighter and an associated behaviour that reduced electrical use.

Q11(a)(i)Some candidates calculated the kWh used by a fridge. Many candidates calculated Wh.

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

Q11(b) Most candidates gave a comparative answer and explained that the old fridge used less power, or that 20W was less than 150W.

Q12 It was pleasing to see that most candidates were able to interpret the table of data correctly and explain why 2500V should be used, referring to the energy or the power in their answers.

Q13 Almost all candidates attempted this six-mark extended writing question. It was pleasing to see that many candidates achieved level 3 by including a calculation in addition to addressing advantages and disadvantages. Most often this was the initial cost of the panels, but sometimes they calculated the electricity produced by 12 panels. It was also pleasing that most candidates achieved at least level 2 by identifying one or two straight-forward advantages or disadvantages. Often the advantages given were 'provides free electricity', 'renewable' or 'no pollution'. Common disadvantages given were 'initial expense', 'less electricity produced when low light level' or 'will not work at night'.

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

General Comments:

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

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

Comments on Individual Questions:

Question No.

1 (Earthquakes)

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

2 (Distant galaxies)

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

3 (Planetary orbits)

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

4 (Global warming)

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

5 (Photons)

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

6 (UV and risk)

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

7 (Digital data)

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

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

8 (Power stations)

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

9 (New fridge)

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

10 (Power lines)

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

11 (PV panels)

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

A182/01 – Twenty First Century Science Physics A (P4, P5, P6) Foundation Tier

General Comments:

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

Comments on Individual Questions:

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

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

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

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

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

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

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

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

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

A182/02 – Twenty First Century Science Physics A (P4, P5, P6) Higher Tier

General Comments:

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

The six-mark extended writing questions were, in general, attempted by all candidates. However, some candidates restricted their mark by only answering one aspect of the question. Other answers were overly long, with much repetition of the question and muddled presentation of physical ideas. A clear, well-planned and concise response can achieve a high mark.

The responses to questions requiring a numerical solution were usually accompanied by the working, which meant that candidates who obtained an incorrect final answer were still able to be awarded some marks if the working was correct. It was noticeable that a large number of candidates had difficulty manipulating numbers involving powers of 10. However, candidates need to be more aware of where using equations at the front of the question paper would enhance their answers.

Comments on Individual Questions:

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

Q1(a) Most candidates were able to read the time the race lasted within the tolerance set on the mark scheme. A few candidates thought the question was asking for the maximum velocity reached.

Q1(b) The majority of candidates selected the correct response, 'average'. The wrong responses were spread amongst all the other options.

Q1(c) Many candidates correctly linked this question with what was happening at the end of the race. However, those candidates who had confused this graph with a distance-time one thought that he slowed down around 3 s because the gradient became less.

Q1(d) The change in the gradient at 2 s was not noticed by many candidates which resulted in incorrect answers between 1 s and 2 s. A single time or a range within the limits 2 s to 2.8 s was accepted as correct. Other candidates confused maximum acceleration with maximum velocity.

Q1(e) This question was answered well. Incorrect responses included 'always accelerating' and 'shows positive correlation'.

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

Q2(a)(i) Many responses did not clearly differentiate between mass and weight. 'Heavier' was the most common answer and this only gained the mark if it was made clear that the ball had more mass. Those candidates who correctly selected and quoted the equation for momentum were awarded the mark.

Q2(a)(ii) This question was poorly answered by most candidates. Many candidates failed to use the fact in the stem of the question that the balls gained the same momentum. Very few candidates used the relevant equation for change of momentum in their answer. Incorrect responses included increased force, discussion of the shape of the ball during the collision and answers that failed to state the effect on the force.

Q2(b)(i) This question was an overlap with the Foundation tier. There were many well set out answers with the correct numerical solution and a statement that the ball would not break the glass. However, candidates needed to justify their answer with the help of the calculation eg. '2.4J<10J' or 'ball only has 2.4J'. Those candidates who obtained an incorrect numerical answer either transformed the mass into weight or failed to square the velocity.

Q2(b)(ii) Few candidates knew that the momenta should be added because velocity is a vector. The most common incorrect answer was 0.4 (kgm/s) as candidates had subtracted the momenta. A few candidates wrongly tried to apply the change in momentum equation.

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

Question 4 Both parts of this question were overlap with the Foundation tier. On the whole this question, on relationships, was answered well by the majority of candidates.

Q4(a) Many candidates drew a straight line on the graph. Some candidates thought that sketch meant that axes did not need to be labelled.

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

Question 5 Candidates found this question, about electricity, difficult. The majority only scored 2 or 3 marks out of the 8 possible for the whole question.

Q5(a)(i) Many candidates chose the correct resistance of 3 (kΩ). The most common incorrect answer was 1 (kΩ).

Q5(a)(ii) A minority of candidates chose the correct answer.

Q5(a)(iii) The idea of potential difference being the work done on/by charge is generally not known by candidates. A few correctly mentioned work done by the battery on the charge passing through it, but even fewer went on to discuss work done by charge on the resistors. Many answers described how the pd is shared amongst the resistors without mentioning work done, or applied Kirchhoff's second law in terms of pd or merely quoted the question. Others tried unsuccessfully applying work done = force x distance to the situation.

Q5(b) About half the candidates selected the correct answer.

Q5(c)(i) The majority of candidates chose an incorrect answer.

Q5(c)(ii) This was poorly answered by most candidates. Many thought that the transformer did not work because it was a series circuit, or the voltage was too low, or because there was a motor in the circuit. Those who gave a correct response usually stated that transformers require ac, but some failed to state that the battery gave dc.

Question 6 This question about a lamp filament was the second six-mark extended writing question. The majority of candidates failed to meet the criteria for levels 2 and 3 since they did not link the thinness of the filament to resistance (or a description of resistance) and to the production of light. Some candidates achieved level 1 by realising that the light emission was linked to the temperature of the wire or the heat produced. Many candidates wrongly thought that the connecting wires were covered in a material such as plastic or that they were too thick to let light escape.

Question 7 Most candidates found part (b) more challenging than part (a).

Q7(a) The use of radiation where cells are killed seemed to be general well known. Few candidates failed to score any marks on this part. Over half the candidates gained both marks by choosing the three correct answers. There was no evidence of candidates choosing more than three options, though a few only chose two or one.

Q7(b)(i) Responses were often not creditworthy as candidates confused 'detect' with 'stopped by'. Such answers stated what gamma and beta did not go through but did not explicitly say which they passed through and therefore would be recorded by the film. There were also misconceptions that lead allowed gamma to pass through it, and that aluminium allowed beta.

Q7(b)(ii) Many of the responses that did not get awarded the mark stated a property of alpha particles (eg can only pass through a thin sheet of paper) but did not relate it to the badge. Candidates needed to say that alpha particles could not penetrate any of the window coverings in order to gain the mark. Some responses only mentioned that it could not go through card, but failed to mention the other window coverings.

Question 8 Candidates found this question, about aspects of nuclear reactors, one of the most difficult on the paper.

Q8(a)(i) The majority of candidates failed to be awarded any marks for this question. There were some well-presented answers which showed all the working and successfully dealt with squares and powers of 10. A few candidates were able to rearrange $E=mc^2$ but then had difficult with manipulating the data. The use of standard form in answers is not widely used.

Q8(a)(ii) About half the candidates correctly stated that more coal would be needed, but only a very few also gave a correct reason. It was sometimes difficult to know whether a candidate meant coal or uranium when the response was ‘it requires more’. Some candidates failed to address the question and wrote about fossil fuels or greenhouse gases or efficiency.

Q8(b)(i) This question produced the greatest number of ‘no responses’ with no attempt made by the candidate for either answer. More candidates successfully gave the proton number, 52, for Te than the mass number, 135. A common incorrect answer for the latter was 137, due to missing the 3 in front of the neutron.

Q8(b)(ii) The majority of candidates’ responses failed to be awarded any marks. In many responses candidates did not use scientific terminology and ideas in explaining how fission reactions are controlled. They tried using everyday terms such as ‘the coolant cools’ or ‘the coolant prevents an explosion’ and ‘the control rods control’. Many attempted to describe what a chain reaction is, but did not know that the particles released were neutrons; protons, electrons and atoms were mentioned. The function of the fuel rods was generally not known.

Question 9 This question, about radioactive waste, was the third six-mark extended writing question. This was an overlap question with the Foundation tier. The best responses at level 3 were able to describe the different categories of waste, linking them to their method of disposal and recognising the harm to health and how it is caused by radiation. The responses meeting the criteria for level 1 addressed either the harm or disposal, but not both. Often the harm, such as cancer, was stated but not explained, and vague descriptions of disposal such as ‘bury it’ were given. The question elicited very long answers with a lot of detail that was not required. The term ‘disposal’ was not understood by some candidates. Some candidates wrote at length about the choices for and against nuclear power without addressing the issues in the question. Other candidates confused different types of waste with different types of radiation.

A183/01 – Twenty First Century Science Physics A (P7) Foundation Tier

General Comments:

The paper examined knowledge and understanding of Physics module P7.

The paper was generally well attempted and produced a good spread of marks across most of the paper, with typical scores ranging from single figures up to the low fifties. The performance of a very small number of candidates indicated that they should perhaps have been entered for the Higher Tier but for the vast majority, the Foundation Tier was appropriate.

Candidates demonstrated a range of skills in their responses. Most candidates were able to show a good understanding of Ideas about Science, although less able candidates clearly have difficulty when for example they are required to compare data to assess levels of confidence or whether ideas are supported or undermined. This is a skill that needs to be addressed in future teaching.

Candidates were able to interpret and evaluate data, in a variety of formats, appropriately in calculations and comparisons. The most able candidates were also able to recall correct scientific terminology, apply abstract ideas about Cepheid Variables and provide scientific justifications for improvements in telescope technology.

Most candidates are showing greater confidence with the six-mark extended writing questions, with evidence of significant amounts of extended writing across the mark range. They are adhering more closely to the rubric information and addressing different aspects in their responses. The most able candidates link their ideas using comparative words in their answers. Further down the mark range, candidates still have a tendency to repeat much of the information provided before introducing an idea of their own. These questions differentiate well. Candidates who achieved well on these questions generally performed well on the paper as a whole.

Comments on Individual Questions:

Question No.

1. This question was about how our knowledge of stars comes from the light we receive from them. It was generally well answered. Candidates were expected to recall and draw how white light is dispersed by a prism. Many drew 3D prisms and consequently found it harder to represent a continuous ray through the prism, which changed direction at a boundary, to gain all three marks. Most candidates were able to select ‘refraction’ as the correct term for the change of direction. The common error was ‘parallax’. Most candidates did not know ‘diffraction grating’ as another method of creating a spectrum. A common incorrect response was ‘star’. Most candidates were able to select words correctly to complete sentences about absorption spectra and interpret line spectra to determine similar elements in a star. Most were able to name hydrogen and helium as the most common elements in a young star. The common errors here were nitrogen, carbon and carbon dioxide.

2. This question was about interpreting the Hertzsprung-Russell diagram. This was also very well answered by many candidates. Most were able to correctly identify regions of brightness and temperature, types of stars and also locate the Sun on the diagram. Many candidates could not recall 273 for converting Celsius to Kelvin. In the explanation for why the Earth could not be plotted on the diagram, candidates often answered simplistically ‘it is a planet’ and so did not gain credit.

3. This six-mark extended writing question, targeted at grades up to E was about describing the life cycle of a star like the Sun. Some candidates recalled the names of the stages, others described them, the best candidates did both and used some good Physics terminology in their responses. However many stages the candidates were able to recall, at Level 2 and 3, most candidates gave the correct sequence of stages.

4. This six-mark extended writing question, targeted at grades up to E was about evaluating data to explain and justify the choice of a site for a new astronomical observatory. A misunderstanding of the term ‘cloudless’ led a number of candidates to choose inappropriate locations. Most candidates did understand the terminology correctly and made justified choices, although explanations were often limited to ‘highest’ or ‘furthest from’. The most able candidates used additional scientific knowledge to explain the factors involved in the choice of location.

5. This question was about the evidence for planets around nearby stars and the likelihood of life existing elsewhere in the Universe. Many candidates knew that planets have been discovered, with many references to exo-planets and ‘Goldilocks zones’. However few candidates were able to express clearly why many discoveries increased the probability of finding life. Candidates were awarded a compensation mark for correct scientific ideas about the necessary conditions for life although this is not a requirement of the specification. Most candidates also knew that no extra-terrestrial life forms have been discovered.

6. This question was about drawing and labelling a diagram of a lunar eclipse. Many drew solar eclipses and were compensated with two marks. The weakest part of many diagrams was the representation of light rays. These were often no more than indicative – which was sufficient for the level of this question for showing the Earth’s shadow.

7. This question was about applying a formula and interpreting data. Most of the question was in common with the Higher tier paper. A common error in the first part of the question was to suggest, simplistically, that the reason why planets further than Saturn were not included in the data was that they were too far away. Many candidates realised correctly that they had not yet been discovered. Most candidates were able to apply the formula correctly, but very few candidates compared their calculation with a given number in order to judge whether a ‘law’ was supported. Only the highest ability candidates judged that the numbers were very similar. Most candidates assessed the number with respect to the calculations for Mars and Jupiter and so ‘yes, because it fits the gap’ was not sufficient to gain credit. In part b(iii) most able candidates gained marks for the idea of that it was necessary to confirm or verify the observation, but very few gained further marks for the idea that this improved reliability, or gave greater confidence in the observation. Some realised that the original astronomer may have been wrong or lying. Less able candidates clearly struggled with this ‘Ideas about Science’ question and their responses indicated that observations by other astronomers were necessary to determine if Ceres was e.g. suitable for life, or a threat to Earth. In part c candidates were presented with further data and asked to discuss the data in relation to ‘confidence in the Titius-Bode Law’. Able candidates compared calculated with actual values and judged that the differences were increasing. Many less able candidates did not understand the question.

8. This six-mark extended writing question targeted at grades up to C was a common question with the Higher tier paper. Candidates were required to explain the improvements in observations afforded by space telescopes and explain how these lead to improved observations of Cepheid variable stars. Many candidates were able to recall that space telescopes removed light and atmospheric pollution from observations, but only the most able could also link improvements to the removal of absorption and refraction effects of the atmosphere. A large number of candidates recalled that Cepheid variables have a period, or pulse, but very few were able to recall the link with luminosity.

9. This Ideas about Science question was about the use of peer reviewed secondary data to make a speed of recession calculation. There is a wide misconception that 'peer' in this context is a friend e.g.at school, or a colleague at work. This difference between the common use of the term and the scientific use needs to be addressed in teaching. Most candidates gained marks for the idea that the work needed to be checked, however. A third mark point was available for the idea that the review is carried out before publishing the research, but was very rarely seen. Many candidates were able to calculate the speed of recession correctly. In the final part of the question candidates were asked to state the problem with the method used to 'reproduce the results'. A few able candidates provided that expected answer that Ian did not measure the distance or that he looked up the data in a book. Many candidates misinterpreted 'reproduce' as a lack of repeats.

A183/02 – Twenty First Century Science Physics A (P7) Higher Tier

General Comments:

The candidates covered quite a wide range of abilities, with the increase in candidates at the lower end of the ability range noted last year continuing. Candidates who are entered inappropriately to the higher tier are often unable to access questions and have very limited opportunities to demonstrate what they know. There was no evidence of candidates running out of time. Very little evidence was seen of candidates ‘killing time’ in the exam by scribbling or ‘doodling’ on the paper, so it appeared that they were kept occupied for a large part of the time. There was a noticeable increase in the number of candidates writing on continuation sheets. This should only be necessary in rare cases. The space provided for answers are an indication of the depth of answer required. Most candidates using extra sheets were simply repeating information from the stem of the question, or from their own answers. Conciseness is desirable in answers, particularly in the 6 mark questions, which also assess the quality of written communication. Candidates did not always note the command word in the questions, for example ‘describe’ requires a different type of answer to ‘explain’. This issue was seen very clearly in question 3(b).

Many candidates lost marks due to not reading through their script at the end of the examination.

Comments on Individual Questions:

Question 1

(a) This was answered well by most candidates. ‘They were too far away to measure’ was the most common error.

(b) Part (i) was calculated correctly by nearly all candidates. In Part (ii) the most common errors were to consider the difference between 2.77 and 2.8 as too great to support the law. A similar error was to reverse the calculation and say that 23.7 was not a whole number so did not support the law. Weaker candidates often did not make any connection with the answer to part (i), just saying it fitted between Mars and Jupiter. Part (iii) was essentially asking ‘what is the value of reproducing measurements/observations?’ Many candidates were keen to use terminology such as ‘peer review’ without thinking more carefully about what the question was asking. Other vague responses included the idea about wanting to know more about the planet, to see if there was life on it.

(c) The best responses normally covered a comparison of agreement for all three planets. A significant number of candidates focused on differences in distances between planets, rather than the differences between the predicted values and the actual distances.

(d) Only a minority of candidates were able to identify the need for a plausible mechanism/scientific explanation. By far the most common incorrect response was to focus on gathering more data.

Question 2

The best responses were succinct and direct in their comments about each aspect of the question. Weak responses merely repeated the information given in the stem of the question. Many candidates were able to identify the absence of atmosphere/air pollution, and some candidates were able to amplify this by including the absence of absorption and/or refraction of light in space. Light pollution and atmosphere were the most commonly stated improvements, with a good number able to explain why being outside the atmosphere was a benefit. A common non-creditworthy response was that telescopes in space have larger mirrors. Weak responses merely repeated the information given in the stem of the question, or referred to lenses/mirrors/apertures/ being closer to stars, or computer controlled. Very few candidates were able to identify the increased baseline provided by the space telescopes, and how this gave rise to an increased and more accurate measurement of parallax angle. Detail of Cepheid variables rarely extended beyond variation in brightness/pulse. The connection between distance, brightness and luminosity was rarely stated.

Question 3

(a) The calculation was done well by the majority of candidates. The most common errors were due to the incorrect rounding in significant figures, and incorrect units.
(b) The relationship was well understood by most candidates, but few provided any explanation of the relationship.
(c) Many candidates merely provided an answer relating to red shift measurements, which did not address the question. Only a minority of candidates were able to state that a large amount of data had been collected in order to provide more confidence in the relationship.

Question 4

(a) The common error was to think that the horizontal axis was distance and the unit km. Of those who knew it was temperature, most also got the unit correct. Luminosity for the vertical axis was not well known.
(b) (i) Many incorrectly thought the colours should be on the vertical axis and the order of colours was often wrong, commonly with blue and red reversed. (ii) Many candidates were able to correctly relate temperature to colour. The best responses, however, also included the relationship between frequency and colour. The most common error was to link red with hot/high frequency and blue with cold.
(c) In part (i) most correctly ringed stars on the main sequence, the most common error was to ring a red giant at the top left of the H-R diagram. (ii) Many candidates scored well here. The common error from weaker candidates was the “fact” that hydrogen is needed to fuel the star or to make helium – the link to ‘fusion is happening so must have hydrogen in’ was often seen.
(d) Many got this right but there were a few who thought black holes weren't stars or that they ‘happen too quickly’.

Question 5

(a) Many candidates were able to state the correct stages for either high or low mass stars. Some candidates failed to relate the level of mass to the sequence they provided. The detailed physical differences between high and low mass stars appeared to be less well understood, and only a minority of candidates were able to provide details of temperature, pressure and density differences between high and low mass stars. The formation of more massive nuclei in high mass stars was observed in some of the better responses. The best responses were ones where the stages of low mass and high mass stars were considered in turn, including appropriate physical differences in the narrative. Many gave detailed discussions of post main stage burning and collapse of stars. The weakest responses were muddled with incorrect stages named or stages/masses jumbled and references to the formation of protostars. Some answers took up large amounts of space and writing time and scored little credit in most cases, for long descriptions of protostar formation from nebulae. The detailed physical differences between high and low mass stars appeared to be less well understood, and only a minority of candidates were able to provide details of temperature, pressure and density differences between high and low mass stars. The formation of more massive nuclei in high mass stars was observed in some of the better responses. A very common misunderstanding was that large mass stars had more fuel and hence had longer lives.

(b) Overall many candidates demonstrated a very limited understanding of standard form. In (i), the most common errors were where candidates tried to take away the 10^{-5}, some divided by 10^{-5} an got a larger number. (ii) Many candidates show a correct numerical solution relationship, but failed to give the relationship ($E=mc^2$) that they were using. A common error was forgetting to square the speed of light. (iii) showed very few correct responses. In many cases there seemed to be no awareness of what a suitable answer would be, e.g. 15 seconds is not very long and 10^{49} seconds is longer than the age of the universe.

Question 6

(a) Many candidates had little understanding of ray diagrams. Detailed ray diagrams, resulting in the correct image formation in the focal plane, were rarely seen. Candidates need to know the way in which rays are refracted as they enter the lens. Candidates often continued top ray without refraction and bent central ray along principal axis. In the high scoring responses, a poorly labelled or shrunken image were the most common reasons for only scoring 3 marks. In the weakest responses it was common to see rays bending in mid-air.

(b) The need for greater magnification was well understood, however a common misunderstanding was that the eyepiece lens did the magnifying. Very few candidates were able to state the relationship between magnification and the focal lengths.

(c) This was generally well answered with many good candidates considering the refraction of different colours and absorption, weaker candidates tended to focus on size and ease of manufacture.

Question 7

Many candidates didn’t fit their answers into the available space and many went onto additional sheets, most such answers were poorly structured and repetitive. The best responses showed evidence of candidates having thought about their answer before writing it down and so wrote to justify their planned conclusion. The weakest responses were characterised by restating data from the table in a random manner, without adding any comparisons or justifications. Mid-range responses often had a scattergun approach, stating the best aspect of some sites with or without justification, or gave reasons for their chosen site without looking at all of the aspects. Many candidates reached the top band but wrote 3 or 4 times the amount necessary and often reached level 3 within the first 6 lines of their response! Candidates should be encouraged to realise that if their answer requires more than the space provided they have possibly missed the point of the question.

A184/02 – Controlled Assessment

Overview

This was the second session for the assessment of the 21C Science suites Investigation controlled assessment. It was a real pleasure to see how most centres had responded to advice and guidance from last year. There were far fewer centres requiring scaling than last year and in general these changes were smaller. However a significant proportion of centres still had their marks altered this session, with large scalings. The most common cause of significant changes to centres marks still relates to the hierarchical nature of the marking criteria, details of which are addressed below.

A serious cause for concern was the increase in malpractice cases. These nearly always involved centres who are giving too much guidance or feedback. They are giving too much guidance because all candidates are following same methods, same limitations and improvements, same references, etc.

Candidates' scripts from a small number of Centres were overly long, although timings indicated in the specification are for guidance only; it was clear that in some instances these had been exceeded markedly to the extent that in some instances this was malpractice. Candidates should not be allowed unreasonable amounts of time and it should be impressed upon candidates that producing reports is an exercise in conciseness.

Administration

A significant number of centres entered candidates for the wrong component, significantly delaying the requesting of manuscripts. Please note that the suffix /01 is for entry via the repository (i.e. electronic copies of candidates work) and the suffix /02 is for the normal postal moderation.

Documentary evidence of internal standardisation was also supplied in a large number of instances, but for many Centres, this was not provided. Cases of significant inconsistent marking seen suggested that internal standardisation procedures had not been applied by some Centres, and Centres are reminded of their obligations:

'It is important that all internal assessors of this Controlled Assessment work to common standards. Centres must ensure that the internal standardisation of marks across assessors and teaching groups takes place using an appropriate procedure.' Section 5 of the specifications suggests some ways in which this can be carried out.

In general the provision of samples was very good, with work sent promptly with all the correct administrative documents. When not correct the most common omission was the CCS160 Centre Declaration although a number of centres failed to attach the Coursework cover sheet to the front of each candidate's work, which always causes problems for the moderator. When submitting samples please do not use plastic wallets, the preferred method for holding a candidates work together is treasury tags. There were few clerical errors this session, but where they did occur they were nearly always the result of careless addition or transcription of marks. Few Centres provided their Moderator with detailed accounts of how the tasks and levels of control were administered; where present, these aided the moderation process.

Annotation

Annotation of candidates' work was excellent in many instances, but variable from Centre to Centre, and sometimes within a Centre. The annotation ranged from *just a series of ticks here and there* to *the relevant skill area code written adjacent to where the point had been made, backed up by a supporting comment.* We would always encourage centres to adopt the latter of the two approaches. Please note that it is a requirement that 'each piece of internally assessed work should show how the marks have been awarded in relation to the marking criteria'.

Hierarchy

A significant number of centres did not treat the criteria as hierarchical. Where this was the case centres were often significantly out of tolerance. Each statement at a lower must be met before marks can be awarded at a higher level. So for example all the criteria at level 1-2 marks need to be met before 3-4 marks can be awarded.

When marking the work each criteria should be annotated where it is met. Beginning with the lowest level and working up to the level where a criterion is not met. This will determine the level of marks awarded. If the candidate meets all the criteria a given level then the higher of the two marks is awarded. Where the candidate meets some of the criteria in a level the lower of the two marks must be awarded.

For example, in strand Eb a candidate who fails to make any comments about outliers is limited to a maximum of 3 marks no matter how well they consider the degree of scatter and general pattern of results. A consequence of this is that it is important that:

- candidates are taught to address lower level criteria as well as higher level criteria.
- teachers take care in identifying where the criteria are met otherwise quite large alterations in marks may result during moderation.

Particular criteria that have not been addressed by candidates are identified below

Interpretation of assessment criteria

Sa – formulating a hypothesis or prediction

For 21C Sciences a scientific hypothesis is a tentative explanation of science related observations or some phenomenon or event. The key point here is the idea of the explanation. A useful hypothesis allows a prediction to be made from it that can be tested experimentally.

The most common difficulties here were insufficient science used to develop the hypothesis. A common mistake was to provide 'a large chunk' of scientific knowledge but not relating this clearly to the development of the hypothesis.

Secondly, major factors were not considered <u>before</u> selecting a factor for the development of the hypothesis. It is not sufficient to state a factor, give a hypothesis and then list other factors as control variables. Candidates are recommended to structure their reports to make this process clear.

At the highest levels 7-8 marks it is important that candidates consider all relevant factors prior to selecting one. A quantitative predication must be derived or related to the hypothesis, not simply an unjustified guess.

It is worth mentioning that work in this strand may not be credited for work in strands Ra or Rb which are carried out under conditions of high control.

Sb - Design of techniques and choice of equipment

In this session, this strand was often generously marked. It was often not possible to justify the centre marks because students limited themselves to a maximum of 5 marks by failing to explain their chosen range of data. It was disappointing to find that the range (of the independent variable) was rarely explained. Centres seemed to believe that just ‘stating’ the range was sufficient. This explanation can be pragmatic, e.g. 'there were only 5 different strength lens available', based on safety issues, or 'the upper end of the range was limited to 2M as any more concentrated would be too corrosive', or based on prior knowledge/preliminary work 'from PE I know students cannot do step ups steadily for more than 3 minutes' or 'my preliminary work showed a reasonable change in the dependent variable of this range'. Note both ends of the range should be mentioned.

Good scientific justifications of the method, equipment and techniques selected must be provided for candidates to be awarded marks in the 7-8 mark level. Some candidates carried out preliminary work prior to the experiment proper. Although not a requirement, if it is practicable to do so in the allotted time, this can help to candidates to justify the method, equipment or range used. Justifications, however, were often weak, and the reasons for the use of a particular method, in particular, were often not provided. Many candidates produced tables, ostensibly to justify the equipment used, but these often listed every piece and simply described how they were used rather than justifying the choice: some very mundane statements were seen. At this 7-8 mark level, candidates should be using terminology such as ‘resolution’, ‘accuracy’ and ‘precision’ in their justifications.

In this strand, candidates are also required to review aspects of Health and Safety, ranging from comments, through to producing full and appropriate Risk Assessments. These were sometimes absent, and where a high mark had been awarded, Centre marks had to be lowered significantly. It is suggested that there is no excuse for omitting Risk Assessments; this phase of the task is under limited control, and more importantly, a Risk Assessment is a prerequisite to any practical work being carried out. Risk Assessment proformas can be used, and these should include the chemical, organism, piece of equipment or activity that is likely to constitute a hazard, the hazard defined (using the appropriate terminology), the associated risk(s), and measures intended to reduce risk. Risk Assessments should pertain to the experiment in question and not to generic hazards and risks (though clearly, candidates are not penalised for the inclusion of these).

Please also note the hierarchy of awarding marks here; hazards must be identified for 3-4 marks, with ’some precautions’ to minimise risk for 5-6 marks. While the word ‘some’ is used, it was not possible to support Centre marks where arguably the most important safety precautions are omitted e.g. the use of low voltage power supplies in electrical experiments. For 7-8 marks, for a Risk Assessment to be ‘full’, it must refer to *all* potential hazards and risks. This includes such things as using low voltage power supplies, limiting concentrations of solutions and the source of biological materials. Here, candidates should be encouraged to use statements such as ‘low hazard’ and ‘limited risk’. Candidates should also consider hazards and risks of a final product of the experiment, e.g. the products of a chemical reaction or incubated agar plate. For a Risk Assessment to be ‘appropriate’, the hazard/risk must be appropriate to that for the chemical/equipment/activity used or undertaken. At this level they should ideally refer to PAT testing of electrical equipment, COSSH, Cleapps Hazard cards or other similar documents and show an awareness of who/where the first aider is in case of injury.

C - Range and quality of primary data

Errors in marking in this strand tended to be at the higher end. The '*correctly recording of data'* at the 5-6 mark level requires meaningful column headings, correct units and consistency in the number of significant figures/decimal places used. To match 6 marks, candidates need to show consistency both with the number of decimal places reported for their raw data and the actual measuring instrument as well as including all quantities and units in table headings.
In strand C there is no need to do more than 2 sets of results if there is close agreement between the two sets obtained. If they are not close, however, then there is a need to do a further repeat for this value –an intelligent repeat. The *regular repeats or checks for repeatability* criterion would then be matched and a possible outlier could be identified. In the new (2011/2012) specifications for Twenty First Century Science, statement 1.6 in the 'Ideas about Science' has clarified the definition and treatment of outliers (compared with the version in the legacy (2006) specifications) to state, *"If a measurement lies well outside the range within which the others in a set of repeats lie, or is off a graph line on which the others lie, this is a sign that it may be incorrect. If possible, it should be checked. If not, it should be used unless there is a specific reason to doubt its accuracy."* Potential outliers in data collected during a Controlled Assessment should be handled in accordance with this statement, with the expectation that at this stage the measurement will be repeated/checked.

Please note that experiments that 'pool' data from a class are not suitable for this controlled assessment. Strand C is based on the primary data collected by the candidate. Data collected by other candidates is secondary data. It is very likely that a student pooling data with other students in a class will be limited to the 1-2 mark level.

A - Revealing patterns in data

Overall, the quality of work in this strand was disappointing. Arguably, this should have been the strand of the Practical Data Analysis where candidates scored the highest marks, but it was here where often the largest discrepancies between Centre and Moderator marks occurred.

Some graphs seen were of poor quality. There was clear evidence that some Centres had not checked the plotting of points carefully before awarding marks. Graphs drawn without appropriate scales, e.g. where these were non-linear, or without one or more labelled axes, and poorly-drawn lines of best fit, were often, incorrectly, awarded high marks. If the scale is inappropriate, or points are plotted incorrectly, the candidate mark cannot exceed four. Likewise, if an inappropriate line of best fit has been applied, a mark above five cannot be awarded, irrespective of whether the candidate has drawn range bars. For marks to be awarded in the highest mark levels, range bars must be drawn accurately (in addition to there being minimal errors in the plotting of data). The scales chosen by candidates often made difficult accurate plotting of data, as did crosses drawn with unsharpened pencils, particularly where millimetre graph paper was used. Although it is not essential that graph scales should start at (0,0), where axes begin with a 'zig-zag' section it is important that candidates do not extend their line of best fit into this 'undefined' area. This bad practice was seen on a number of occasions.

Please note that if computer generated graphs are produced they will be marked in exactly the same way as hand drawn graphs. In particular the grid lines on the graph must allow the plotting to be checked to 2 significant figures.

In some instances, however, candidates that were awarded very low marks having drawn very poor graphs could be awarded three or four marks owing to their calculations of means, a point sometimes overlooked by Centres.

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

Ea - Evaluation of apparatus and procedures

This was generally well assessed by centres however the common errors consisted of over marking candidates who suggested improvements but did not consider the limitations, hence not meeting the criteria at 3-4 marks.

Some improvements mentioned were trivial or lacked the detail required for higher marks. In general doing more repeats is unlikely to be a significant improvement.

There was some confusion over improvements to the experimental procedure and apparatus which is addressed here in Ea and the additional data or methods which can be used to increase confidence in the hypothesis which falls in stand **Rb**

Eb - Evaluation of primary data

A major stumbling point here was the requirement for outliers to be considered at level 3-4 marks. A significant number of centres ignored this requirement. In addition there appeared to be some confusion over what an outlier is, both amongst candidates and teachers. The criteria state *'individual results which are beyond the range of experimental error (are outliers)'*. Not all anomalous results are outliers, in particular averages are not outliers and a set of data points for a single value cannot all be outliers. In the new (2011/2012) specifications for Twenty First Century Science, statement 1.6 in the 'Ideas about Science' has clarified the definition and treatment of outliers (compared with the version in the legacy (2006) specifications) to state, *"If a measurement lies well outside the range within which the others in a set of repeats lie, or is off a graph line on which the others lie, this is a sign that it may be incorrect. If possible, it should be checked. If not, it should be used unless there is a specific reason to doubt its accuracy."* Potential outliers in data collected during a Controlled Assessment should be handled in accordance with this statement. Candidates are permitted to draw a graph of their results during the (limited control) data collection stage of the Controlled Assessment task. This may help them to identify potential outliers. Ideally, any data points that look to be potential outliers should be re-measured, and this is easiest to achieve if they are identified during the data collection session ie. strand C.

For 5-6 marks, although there were some often good discussions of spread of data, ‘repeatability’ was not always discussed. Candidates should discuss the spread of data qualitatively at this level, and quantitatively to obtain the highest marks at the top mark level at 7-8marks. Candidates’ evaluations were often very long, but many covered the pertinent points in the first few sentences.

Ra - Collection and use of secondary data

This strand was poorly addressed by many candidates.

The intention in Strand Ra is that candidates should do some research and find their own examples of secondary data. The OCR data in the 'Information for candidates (2)' document is only provided as a back up for those who fail to find any relevant secondary data from their own research.

Generally candidates are limited to 5 marks in Strand Ra if all they use is the OCR data and/or results from another candidate or group. In order to access 6 or more marks in Strand Ra candidates must present a 'range of relevant secondary data', which means that some data from the candidate's own research must be included and the source(s) of the data must be fully referenced. Guidance on referencing can be found in the 'Guide to Controlled Assessment' handbook for Unit A154 / A164 / A174 / A184 (Practical Investigation). The direct download link is http://www.ocr.org.uk/Images/77479-guide-to-controlled-assessment.pdf

Secondary data can be of different types:

- the data provided by OCR in the 'Information for candidates (2)' document;
- data collected by other candidates doing the same (or a similar) investigation;
- data from other sources (e.g. textbooks or the internet).

Data do not necessarily have to be quantitative; they can be qualitative. Students do not necessarily have to find a table of numbers that looks exactly like the one they have generated from their own experiment; graphs, descriptions of trends, conclusions, mathematical relationships, relevant constants, models and simulations can all be presented as secondary data.

It is helpful to the moderator if candidates included copies of the secondary data that they discuss in their report. This could be cut and pasted into the report (so long as it is clearly identified as third-party material), or may be attached to the end of the report. The material included should be carefully selected and cropped to show only the relevant parts, rather than comprising swathes of irrelevant material indiscriminately printed out.

Rb - Reviewing confidence in the hypothesis

This strand was also over-generously marked by some Centres. Candidates should be encouraged to re-state their hypothesis at the beginning of the review section to provide focus for this strand. Candidates often discussed findings but did not refer the hypothesis at all, or say if their data supported it. All candidates should make at least a statement referring to whether the hypothesis has been supported (or not), and the extent to which the data support the hypothesis.

At the 3-4 mark level upwards, candidates should make reference to some science when explaining their results. This was rarely done. It is not sufficient to merely refer to science used in Sa, as Sa is carried out under conditions of low control whereas Rb is done under high control conditions. At level 5-6 the science must be used to support the conclusion about the hypothesis.

When giving an account of extra data to be collected this must go beyond simply suggesting improvements to the procedure used, which is assessed in Ea. Different techniques or experiments that will provide additional data to assess the hypothesis are required for this strand.

Sources of Support

OCR offers several avenues of **free** support, including:

- The Principal Moderator's Report can be found on the OCR website.
- A 'Guide to Controlled Assessment' handbook for Unit A154 / A164 / A174 / A184 (Practical Investigation). The direct download link is http://www.ocr.org.uk/Images/77479-guide-to-controlled-assessment.pdf
- INSET training events for 2013-14 are available details may be found on the OCR website at http://www.cpdhub.ocr.org.uk

- We offer a Controlled Assessment Consultancy service, in which candidate work that you have marked will be reviewed by a senior moderator prior to moderation.
  To make use of this service, post photocopies of three marked pieces of work to the following address: *Carolyn Brawn, Science Team, OCR, 1 Hills Road, Cambridge, CB1 2EU*.

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

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