Oxford Cambridge and RSA

GCSE

Physics A

Twenty First Century Science Suite

General Certificate of Secondary Education **J245**

OCR Report to Centres June 2016

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General Certificate of Secondary Education

Physics A (Twenty First Century) (J245)

OCR REPORT TO CENTRES

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

General Comments:

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

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

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

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

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

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

Comments on Individual Questions:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Question 12
12 We saw very encouraging responses that suggest many GCSE students understand the actions required to reduce global warming and improve the environment. Those candidates who addressed Brian's comments made some very good points A few candidates expanded on these with extra detail. There were some good answers that covered alternative transport and candidates could suggest many improvements. As well as those points specifically mentioned on the mark scheme, which were often seen, candidates suggested car sharing, hybrid cars, and driving more slowly. Some explained that a bus uses more fuel than one car and saves energy by replacing many cars. Similarly, with insulation, candidates explained how badly insulated buildings resulted in heat loss and suggested many ways of reducing the energy waste. Alternative sources of power were often suggested. Students lost marks most often by not covering both parts of the question. Some candidates did not focus on Brian's comments but talked instead about leaving lights on, and turning them off, or not wasting energy. They were given some credit for these answers.

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

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

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

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

General Comments:

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

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

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

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

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

Comments on Individual Questions:

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

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

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

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

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

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

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

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

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

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

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

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

Question 11
This extended response 6-mark question was well answered by most, but level 3 responses require use of all the information given: not only the ideas of sustainability and environmental impact of different power stations (which was very well tackled by almost all candidates) but also the fact that developing countries have increasing populations with increasing urbanisation which was in the stem of the question.

A182/01 Physics A Modules P4, P5, P6 (Foundation Tier)

General Comments:

The paper was slightly more challenging this year, as there were more unfamiliar contexts than in recent papers. Candidates coped well in the main part with this.

Candidates fared better with the mathematical questions in this paper than in previous years and Centres should be congratulated on preparing candidates well, for this type of question.

There were a variety of question formats included as in previous papers. There is still evidence to suggest that candidates are not reading the instructions carefully and making up their own mind about how many lines to draw between answer boxes.

When answering the six-mark questions there is some evidence that candidates are not answering all aspects of the question. Again this could be improved by candidates taking time to read the questions carefully and ensuring that all of the aspects are covered in their answers.

Comments on Individual Questions:

Question 1
1(a) The vast majority of candidates knew the direction of movement of the electrons from the cloth to the rod.

1(b)(i) Many candidates ignored the instruction to use one line to complete this question and as a result did not gain any marks.

1(b)(ii) The candidates found this question tricky with many not realising that the rod was an insulator.

Question 2
2(a) Some candidates did not add the arrow to the diagram, and many others added arrows to show the flow of current.

2(b) This was answered well with many candidates either reversing the current or reversing the poles of the magnet.

2(c) The vast majority of candidates realised that the device that made use of this effect was the motor. The lamp was also a popular choice.

Question 3
3(a)(i) Many candidates found this difficult and could not use the power given in the table to work out that the spiral bulb used the most energy each second.

3(a)(ii) More candidates recognised that 230V was the mains supply in the UK and therefore the fluorescent bulb was the correct answer.

3(a)(iii) The majority of candidates worked out that two cells would power the filament lamp in this case.

3(b)(i) The vast majority of candidates were correct when circling the ammeter symbol in the circuit. A significant minority did not answer this question and candidates should be reminded to read the instructions carefully.
3(b)(ii) Candidates fared well on this mathematical question. It was pleasing to see the large numbers of candidates carrying out the correct calculations and then using these to describe the correlation.
3(b)(iii) Almost all the candidates could suggest that repeating the results was a way to improve the experiment.

Question 4
This question was common to the higher paper and as such should be a challenging question on this paper.
Many candidates gained 3 marks on this question by describing the correlation and then giving one improvement; a second improvement would have increased this to 4 marks. Many candidates used the term "negative correlation" which was pleasing to see.

Very few candidates on this paper attempted to explain why the resistance decreased as more wires were added. Some did use the "more paths" argument, which was enough to gain full marks.

Question 5
5(a) It was very pleasing to see the large number of candidates who understood the term half-life, could apply this to the data in the table, choose B as the correct answer, and justify their answer clearly using the data from the table.

5(b) Many candidates confused the use of the tracer in the question with the use of radiation to treat cancer. The idea that the risk of getting cancer from the tracer was small was understood by many candidates and gained a mark. Some of the better candidates were fully able to give good arguments that the benefits of using the tracer out-weighed the risks and that this could lead to diagnosis and then treatment of the problem.

Question 6
6(a) Not many candidates could choose the correct process in this question with all of the other answers being chosen frequently.

6(b)(i) The candidates who used the bullet points to address each method of disposal usually gained three marks on this question. There were very many vague answers about radiation being dangerous or harming the environment that were not credit worthy.

6(b)(ii) Most candidates could state that low level waste was less risky or less radioactive than high level waste and this type of comparative statement gained the mark.

6(c) Many candidates wrote about the small chances and low risk of an accident, with the more able giving some details about the safety features/control systems in the power station.

Question 7
Candidates who stated what they knew about the alpha and beta radiation scored well on this question. Reference to cancer was a common correct answer, although many candidates gave vague answers about radiation being dangerous. There was widespread misunderstanding of "ionisation" and many candidates saying that beta was more ionising than alpha, and that this was the reason for the need for shielding.

Question 8
This question was generally answered very well.

8(a) Most candidates used the correct number of lines and many of them correctly identified the motion of the lorry from the graph.

8(b)(i) This was answered very well by almost all candidates. A few gave 15.6 as an incorrect reading from the graph.

8(b)(ii) Again this question was answered very well and the vast majority of candidates scored the mark.

8(c)(i) Candidates universally used the correct number of lines in this question, and X was almost always correctly connected to the driving force. Y was often connected to the counter force as an incorrect answer.

8(c)(ii) Many candidates correctly explained that the forces or arrows were "the same" but fewer candidates could explain that they were in opposite directions.

Question 9

The candidates found this question difficult. Hardly any candidates discussed the increased time for momentum change leading to a smaller force and hence very few candidates gained 5 or 6 marks.

Many candidates did understand the concept of cushioning and there were frequent references to other examples of the same ideas e.g. crumple zones or crash helmets.

Candidates should be encouraged to apply their knowledge to more novel contexts to prepare them for this type of question.

Question 10

10(a)(i) Candidates found this more difficult than expected with many answering 20N by missing the weight of the box.

10(a)(ii) Many candidates did get the error carried forward from the previous part of this question. Hardly any candidates managed to give the correct unit of energy.

10(a)(iii) Hardly any candidates could state anything creditworthy about conservation of energy, and even fewer could apply this to Roy.

10(b) The vast majority of candidates scored this mark with the answer D.

A182/02 Physics A Modules P4, P5, P6 (Higher Tier)

General Comments:

There were very few scripts with ‘no response’ answers at the end, indicating that the vast majority of candidates were able to complete the paper in the time allowed. The responses and the number of ‘no response’ answers throughout the paper, including the multiple choice questions, from some candidates indicated that it would have been better for the candidate to have been entered for the foundation level paper. Most candidates showed that they had been prepared for answering the variety of styles of questions.

The six-mark extended writing questions were, generally, attempted by all candidates, with few ‘no response’ answers. Some candidates limited themselves to the level that they could obtain by only addressing one aspect of the question. Some responses were poorly organised and did not display good quality of communication. Well-planned and concise answers commenting on all parts of the question are more likely to achieve a higher level.

In descriptive answers, candidates often displayed some idea of the physical principles involved but they need to express these ideas more explicitly and to only use those appertaining to the question asked.

There was evidence that candidates could cope with the mathematical demands of the questions. Some candidates did not show their working and consequently where their answer was incorrect they could not be given any compensatory mark. Where data is given in a question they should be used in the answer. Some candidates did not refer to the relationships given at the front of the paper and some who did either wrote them wrongly or chose the wrong equation.

Comments on Individual Questions:

Question 1
1 This question required candidates to use forces and transfer of energy. The majority of candidates scored at least 2 marks, usually in parts (a)(i) and (a)(ii). Only a small minority of candidates scored any marks in parts (a)(iii) and (b).

1(a)(i) The most common wrong answer was 20, due to forgetting to add the weight of the box.

1(a)(ii) Error carried forward was applied from part (a)(i) but many candidates failed to see the relationship between the two parts. The unit was often wrong or omitted. Most common wrong unit was N, N/m or gpe.

1(a)(iii) The majority of candidates did not know the principle of conservation of energy. Many answers gave the meaning of conservation as retention or saving in reserve. Those candidates that did state the principle were often not able to relate it to Roy’s situation. Heat was mentioned as wasted energy but not linked to the GPE of the tins and the total work done by Roy. A number of answers assumed the GPE of the tins became heat.

1(b) Most candidates did not see that the question was about transferring GPE to KE. Some calculated the GPE as 48 J but did not link it to KE. A few candidates gave well-explained answers showing their working. Some tried using the equations for average speed or momentum.

Question 2

2 Most candidates scored at least 3 marks for this question dealing with forces and motion. The three parts in part (a) produced better answers than those in part (b).

2(a)(i) A common wrong answer was 20.

2(a)(ii) Those candidates who chose the correct distance of 130 usually calculated the average speed correctly. The most common wrong answer was 7.5 obtained by candidates who read the distance as 150 m.

2(a)(iii) Less than half the candidates chose the correct answer.

2(b)(i) The correct term, reaction, was not known by the majority of candidates. Common wrong answers were upthrust, lift, gravity, air resistance and resultant.

2(b)(ii) There were just a very small number of candidates who gave answers showing an understanding of what an interaction pair of forces is, usually by saying that they act on different bodies. A significant number of candidates argued wrongly that an interactive pair are not equal otherwise the lorry would not move.

Question 3

3 There were many good answers showing an understanding of the action of seat belts and airbags in lengthening the time to stop the passenger in a collision and thus reduce the force, leading to a level 2 mark. There were also answers that succinctly used the equation of change in momentum to link the momentum, force and time and achieved level 3. Answers giving just a description of how injuries were produced were awarded a level 1. Few candidates failed to achieve a mark for this question.

Question 4

4 The working of a transformer was not known by the majority of candidates. Many seemed to be describing a generator with spinning magnets. Those who showed understanding usually mentioned the magnetic field in the core but omitted the alternating current in the primary coil or that the magnetic field is changing. A compensatory mark was awarded to those candidates who stated that the output/secondary voltage is lower than the input/primary voltage. However, they often left it as either an increase or decrease, without stating which.

Question 5

5 Most candidates scored 3 or more marks for this question, showing understanding of electromagnetic induction.

5(a)(i) The correct term is not known by most candidates.

5(a)(ii) Many answers indicated a change in direction or use of the south pole, but ambiguous terms such as rotate or spin the magnet were not accepted.

5(b)(i) About half the candidates gave acceptable answers such as more current, more voltage or more power. Those that chose more energy often did not get the mark as they failed to link it to time i.e. increased rate of energy transfer.

5(b)(ii) A majority of candidates chose the correct graph.

5(b)(iii) Iron was the most common correct answer, given by about half the candidates. Common wrong materials were copper, steel, (just) metal and magnet.

Question 6
6 Most candidates chose the correct names for parts (a)(i) and (a)(ii). The rules governing voltages and currents in series and parallel circuits are either not well known or candidates have difficulty applying them.

6(b)(i) Of the four parts in (b) and (c) candidates answered this part the best. Some candidates had difficulty dividing by 0.2.

6(b)(ii) Many candidates did not recognise the significance of both voltmeter readings in the question. Common wrong answers were 1.5 V and 1.0 V.

6(c)(i) Less than half the candidates were able to give the correct voltage. The most common wrong answer was 3.0 V.

6(c)(ii) Only a few candidates gave the correct answer. The most common wrong answer was 0.4 A.

Question 7
7 Most candidates were able to state the correlation and so access level 2, but did not attempt an explanation so could not access level 3. Many level 2 answers gave two improvements, such as repeating the experiment and using more or less wires, but some candidates could only be awarded the lower mark of 3 since they only gave one improvement. Vague statements such as 'get more results' were not credited. A few candidates gave an explanation in terms of more pathways for the current to be awarded a level 3. However, explanations in terms of collisions were not credited as they did not answer the question.

Question 8
8 Half the candidates scored at least one mark for this question. Many candidates did not show an understanding of how an injected tracer works and failed to read the information in the question carefully enough. Some ignored the statement that the source needed to have a half-life of one hour and instead looked for the one with least activity, to prevent causing cancer, or most activity, to get a good reading. Many thought that alpha is less damaging to humans than gamma and few appreciated that it needed to be gamma in order to exit the body. Many failed to get a mark for correct ideas about the meaning of half-life as they did not follow the instructions in the question to justify their answer using the data in the table. The terms half-life and activity were often interchanged such as in the incorrect statement 'the half-life of C is 500'.

Question 9
9 Most candidates were able to score at least 4 marks in this question.

9(a) Half the candidates wrote down the correct equation either in word form or by substituting the correct values. Some, however, forgot to square the speed of light.

9(b) Half the candidates gave at least one correct method of disposal. Some failed to gain marks as their answers were too vague, such as 'put it in a container' or 'bury it' The material from which the container is made and the qualifying word 'deep' were needed. Amongst the wrong methods were: burn it, release it into the atmosphere, dump it in the sea and put it in landfills.

9(c) Candidates often only gave one reason. They did not refer to the number of marks to direct their answer. Many answers failed to address the question as they tried to justify why he need not worry, such as descriptions of safety and control methods at power stations. Most common correct reasons were previous events publicised in the media and consequences of a disaster.

9(d)(i) Many answers just stated a property of alpha rather than applying it to the situation in the badge, examples such as 'alpha does not pass through paper', 'alpha only goes through a few cm of air' and 'alpha is the least penetrating'. In order to gain the mark candidates needed to say that alpha does not go through card, aluminium or lead, or to say it does not penetrate any of the windows.

9(d)(ii) The line for beta was correct more often than that for gamma. Some candidates ignored the instructions in the question and drew multiple lines from each of the types of radiation.

Question 10

10 Of the three extended writing questions in this examination paper, candidates found this the most difficult to answer. There were very few level 3 answers, which required a detailed explanation of the process using the idea of ionisation and the action of ions. Many candidates stated that the radiation killed bacteria which gave access to levels 1 and 2. Many reasons to explain why Donna's concerns were unfounded were confused and did not correctly differentiate between irradiation and contamination.

A183/01 – Physics A Module P7 (Foundation Tier)

General Comments:

The paper examined knowledge and understanding of Physics module P7. The eight questions included three 6-mark (Level of Response) extended writing items and they covered all five topics of the P7 syllabus.

The paper was generally well attempted and produced a good spread of marks 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. Questions examined the ability to recall and select knowledge, to apply skills, knowledge and understanding in unfamiliar contexts and to analyse and evaluate evidence to make reasoned judgements and draw conclusions.

Some questions in particular were good predictors of the overall performance of the candidates. In these questions, the most able candidates were able to apply knowledge of relative sizes and distances to explain solar eclipses; describe a sequence of changes related to nuclear reactions in low mass stars and; give a balanced argument regarding the merits of investing in a space telescope.

Comments on Individual Questions:

Question 1
This question addressed syllabus statements in P7.1 Naked eye astronomy. Candidates were given a diagram of a time-lapse observation of the night sky and asked to justify two conclusions regarding the direction and duration of the observation. Most candidates, at this level, did not deduce that the image could only be produced by directing the telescope at the Pole star and therefore did not draw a correct conclusion about the direction. Most gained marks for supporting the conclusion about the duration of the observation but only the more able equated the one-quarter turn to a 6 hour time period. In the third part of this question most candidates recognised that the reason for a different observation of the night sky was due to Earth's rotation around the Sun but many did not develop their argument to explain what the different observation was – i.e. different stars.

Question 2
This six-mark extended writing question, targeted at grades up to E also addressed P7.1. The most able candidates at this level were able to produce very good diagrams showing the relative sizes and distances of the Sun and Moon and the positions they must be in to produce a solar eclipse on Earth. Often, these candidates attempted to draw rays to show regions of shadow. Although, all marks could have been gained from a labelled diagram alone, there were many good explanations of the phenomenon. Weaker candidates tended only to express the idea of the Moon blocking the light from the Sun with little or no appreciation of the effect of relative size and distance.

Question 3
This question addressed syllabus statements in P7.3 Mapping the universe and P7.4 The Sun, the stars and their surroundings. A very common (and incorrect) answer to the first part of this question about the age of the Universe was 14,000 billion years. In the second part, most candidates were able to use the data correctly in the speed of recession formula. Part 3 of the question proved more challenging. Candidates needed to convert a temperature of 3 kelvin to a temperature in degrees Celsius. Recall of -273 and correct addition was required for both marks.

Question 4
This question addressed syllabus statements in P7.4 and also tested mathematical skills. Candidates were given data relating to the distances of five stars. Four distances were similar and one was a clear outlier. Candidates were informed that four of the stars were formed in the same nebula and were instructed to calculate the mean distance to these stars. Many candidates selected the correct four stars and calculated ‘170’. The third mark on this question was for explaining their answer. Many candidates interpreted this as: explain how you calculated the mean. They should, of course, have explained why they chose those particular stars.

Question 5
This six-mark extended writing question, targeted at grades up to E addressed P7.4. Candidates were required to recall how low mass stars similar to the Sun evolve to become red giants and then shrink to become white dwarfs. Almost all candidates were able to describe a physical change as the low mass star evolved. Many were able to name one of the stages, but very few got both red giant and white dwarf. Only the most able candidates at this level were able to recall the fusion of heavier elements as the star runs out of hydrogen.

Question 6
This question addressed syllabus statements in P7.2 Light, telescopes and images. Most candidates were able to apply the formula: power = 1/focal length or use the relationships in the data table to deduce one or both of the correct answers in the first part of this question. In part 2 of the question, candidates were required to choose the lens that would be the best objective lens for a telescope. Many candidates correctly identified the lens with the largest diameter (D) but very few were able to relate this large size to the increased amount of light that it would capture. In the third part of this question, candidates were required to identify three changes to light as it enters a lens at right angles to the surface by circling the correct word. Many candidates were able to identify that wavelength would change but only the most able recognised that this was due to the change in speed. The third mark is more difficult to analyse but it would appear that the term ‘at right angles to’ has confused most candidates.

Question 7
This question addressed syllabus statements in P7.3. Candidates were required to identify and label the objects on a diagram that illustrates how parallax is used to measure the distance to nearby stars. Most candidates were able to identify the star but did not discriminate when labelling the background or distant stars. The symbols representing the baseline of the parallax diagram were also frequently mislabelled; a common misconception being that these represented parts of a telescope. Very few candidates at this level were able to correctly identify the parallax angle. In the third part of this question, candidates needed to calculate a distance based on a seconds of arc measurement. Candidates appear to be familiar with the format and many made the correct substitution. However, as very few candidates were able to identify ‘parsec’ as the correct unit, it would appear that they may have only been recalling how to do the calculation rather than applying the definition of the parsec unit of distance.

Question 8
This question addressed syllabus statements in P7.5 The astronomy community. Most candidates were able to describe at least one advantage, using Ideas about Science, for international collaboration on large space projects. Many also recognised that decisions about the distribution of funding for scientific projects are made by governments.

8(b)(ii) This six-mark extended writing question, targeted at grades up to C also addressed P7.5. When answering 'for and against' style questions candidates should be encouraged to make as many points as possible. The most able candidates were able to describe the advantages for producing much better images and explain why. They were also able to describe particular difficulties relating to access and cost. Candidates were also able to gain credit for recognising that such technology was there to make new discoveries, satisfy scientific curiosity and produce awe-inspiring images to motivate others into studying astronomy.

A183/02 – Physics A Module P7 (Higher Tier)

General Comments:

The candidates covered quite a wide range of abilities, with a large proportion of candidates at the lower end of the ability range. 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 at the end of the paper. When this is done it should be clearly indicated that the answer is continued. This should only be necessary in rare cases. The space provided for answers being an indication of the depth of answer required. Most candidates using extra sheets where simply repeating information from the stem of the question or from their own answers. Conciseness is desirable in answers, particularly the 6 mark questions which also assess the quality of written communication, with most filling the available space with writing.

Candidates did not always read the full question in the 6 mark extended prose questions and as a consequence only addressed part of the question, often limiting the marks available to them, some practice in planning answers to the 6 mark questions might be helpful.

Many candidates did not have the mathematical skills required for the higher paper, this was particularly apparent in Q4 and Q6, where the weaker candidates were often at a loss as to how to address the questions. A significant proportion of candidates gave answers to many of the calculation questions showed no or little working. These answers may be incorrect just by a power of ten and if working had been shown then some credit could have been given.

Comments on Individual Questions:

Question 1
1(a)(i) In labelling the diagram the most common errors were candidates not being specific when describing the 'distant/background' stars. Most candidates not meeting this marking point simply labelled these as 'stars' and treating the diagram as a lens diagram and so labelling the star to be measures as the 'focus' or 'focal point'.

1(a)(ii) The most common error was drawing the angle between the 2 dashed lines i.e. twice the half-angle.

1(b) The most common calculation errors arose where candidates thought that they needed to use trigonometric functions (sin 0.71 etc.) or that they needed to address the 'seconds' and so were dividing by 3600 etc. Many candidates who were not able to carry out the correct calculation still managed to state the correct unit and so score 1 mark. The most common incorrect unit given was the light-year.

Question 2
2(a) The most common correct responses were centred around the idea of sharing costs. The small number of candidates not scoring on this question often referred to outcomes i.e. 'lots of countries get to use the telescope' or 'findings can be shared'.

2(b)(i) The most common correct response was 'governments'. The most common incorrect responses were; NASA, ESA, the public and Astronomers.

2(b)(ii) When giving advantages and disadvantages, candidates should aim to produce a balanced view with an equal number of advantages and disadvantages. They should not be over-influenced by their own personal opinion. The used of good scientific language (refraction, absorption, etc.) is more likely to access higher levels of marks. The majority of candidates were able to identify some of the following advantages and disadvantages; clearer images, no light pollution, no atmospheric pollution, expensive to set up, expensive to maintain, difficult to maintain and new discoveries. Alongside this, a significant number recognised that a broader range of electromagnetic waves would be detected and that money could be spent elsewhere.

The most common responses that were not worthy of credit were: better for the environment, can use computers to control telescope/process data, less 'interference' unqualified (not many candidates were able to state specifically what was happening to the radiation e.g. refraction, absorption, scattering etc.), difficult to get to (for viewing).

Question 3

3(a)(i) Many candidates were unable to give clear responses to this question. Although the majority of candidates referred to changes in wavelength, speed or direction, many did not state the nature of the change. The most common correct response was 'light slows down' which, due to the nature of the question stem, was taken to mean 'when passing into the lens'. Very few referred to the passage of light into or out of the lens. A small number of candidates incorrectly referred to frequency changes.

3(a)(ii) Where attempted, this question was not well answered. Many candidates either ignored the pre-drawn top ray, choosing to replace this with a ray directed towards the principal axis or showed the bottom ray refracting and then running parallel to the principal axis.

Many candidates, however, recognised that the centre ray continues in a straight line and the majority were aware that the image is formed where light rays cross albeit not always where all three lines crossed.

3(b)(i) The most common incorrect responses were 'Y' and 'Z' presumably because they had the longest focal length and largest diameters respectively and so presented the largest values within a given column of the table.

3(b)(ii) Although many candidates selected the correct lens (W), a significant number did not use an appropriate superlative adjective when stating their reason for choosing the lens i.e. 'short' focal length rather than 'shortest' or 'powerful' rather than 'most powerful'.

3(b)(iii) A common misconception was that a longer focal length would be best for viewing distant objects. Those correctly identifying 'Z' often then did not either use the superlative when describing the diameter or link the diameter to light collection.

3(b)(iii) Candidates tended to either take a mathematical approach by first calculating the magnification to show that the magnification was actually 30 and then explaining that this was still the highest magnification or they took a qualitative approach and stated that this combination of lenses would give the highest magnification but that this was not a magnification of 300, often then evidencing this with a calculation. Both of these approaches tended to arrive at 2 or 3 marks. A smaller number of candidates were able to give a reason why this combination was the highest magnification.

Question 4

4(a) The most common error was to calculate the mean of all distances. The explanation was often stated as 'this is the average'. Another common error was to calculate half of the furthest distance or half of the range and suggest that the best estimate for the cloud is somewhere in the middle.

4(b) A small but significant number of candidates were able to identify range of the values they used in part (a) and hence gained this mark.

Candidates generally knew how to calculate a mean but the uncertainty was which numbers to use. Most calculated the mean of all the stars.

Question 5

5 This question proved to be the most challenging. Most candidates did not read the question carefully enough to realise that it is the value of the Hubble constant that required support from the Cepheid variable measurements and not the distance obtained from the Hubble equation. It is important to present information in a logical order in this case starting with closer Cepheid variables, then moving to slightly further galaxies then the use of Hubble equation in more distant galaxies.

The most common errors involved many candidates referring to the idea of pulsating stars/'period' or measuring observed brightness. Fewer candidates successfully linked luminosity, observed brightness and distance to star. Very few candidates linked Cepheid variable stars within Galaxies.

The majority of candidates who mentioned the Hubble constant either stated the equation as given without suitable rearrangement or gave confused ideas about using the Hubble constant to work out the speed of recession.

Question 6

6(a) There is some confusion among candidates between "fission" and "fusion" as well as knowing that Helium is a product of the reaction and not a reactant.

6(b)(i) Very few candidates stated the correct rearrangement of the equation before substituting in values. Most common errors were; omission of the 'squared' in the working/calculation and incorrect processing of the data in standard form resulting in power of ten errors.

6(b)(ii) The most common error was to multiply the two relevant values or to introduce another value into the equation e.g. their answer to (b)(i) or the speed of light. Again, as in (b)(i), candidates were not always able to correctly process values in standard form.

6(c) The most common marking points met were 'produced in core' and 'light/radiation/photons from surface/photosphere. Although many candidates partially described the transfer of energy within the star, few mentioned both convection and radiation. This was a less common, but still significant, issue with the idea of energy being radiated at the surface. Some candidates gave a partial description e.g. 'light is then given out' (not stating where from) or 'it leaves the surface' (not telling us the form of the energy).

Question 7

7 This question again required logical sequencing of ideas. It is confusing to both candidate and examiner when answers to the three parts of this question are mixed together. Some of the misconceptions encountered were as follows; the stars are actually fixed in space (only true with respect to Earth), the tilt of the Earth's axis explains the different times, the spin of the moon affects the time it takes to travel, the relative distances and sizes of the objects. Diagrams were successfully used by a number of candidates to show the spin of Earth and its orbit around the sun.

A184 – Physics A Controlled Assessment

General Comments

Overview

This was the fourth session for the assessment of the Twenty First Century Science suite's Investigation controlled assessment. It was a real pleasure to see how most centres had responded to advice and guidance from previous years. There were fewer centres requiring adjustment than last year and in general these changes were smaller. 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 continues to be 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. Much inconsistent marking seen suggested that internal standardisation procedures had not been applied by some centres, and centres are reminded of their obligations:

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

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

Few centres provided their moderator with detailed accounts of how the tasks and levels of control were administered; where present, these aided the moderation process.

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 level must be met before marks can be awarded at a higher level. So for example all the criteria at level 1-2 marks need to be met before 3-4 marks can be awarded.

When marking the work each criterion should be annotated where it is met. Beginning with the lowest level and working up to the level where a criterion is not met. This will determine the level of marks awarded. If the candidate meets all the criteria at a given level then the higher of the two marks is awarded. Where the candidate meets some of the criteria 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 Twenty First Century Sciences a scientific hypothesis is a tentative explanation of science related observations or some phenomenon or event. The key point here is the idea of the explanation. A useful hypothesis allows a prediction to be made from it that can be tested experimentally.

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

Secondly, major factors were not considered <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, 'there were only 5 different strength lens available', based on safety issues, 'the upper end of the range was limited to 2M as any more concentrated would be too corrosive' or based on prior knowledge/preliminary work 'from PE I know 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 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 '*correct 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 7-8 marks. 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:

- 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
- 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 Spiller, 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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