RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced GCE **H558**

Advanced Subsidiary GCE **H158**

OCR Report to Centres

June 2012

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

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

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

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

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

CONTENTS

Advanced GCE Physics A (H558)

Advanced Subsidiary GCE Physics (H158)

OCR REPORT TO CENTRES

Overview

Well done to Centres for preparing their students for the Physics A theory papers. It was clear from candidates' responses that many Centres had once again made good use of Principal Examiners' reports, examination papers and marking schemes.

The quality of analytical work has definitely improved, but sadly, there still remains a significant cohort of candidates who are defeated by the simplest mathematical tasks. In the AS units, a disappointing number of candidates could not rearrange simple equations or substitute values logically into equations. The standard of mathematics was much better in the G485 paper, with many candidates showing good understanding of logarithms and exponential functions.

The quality of written work requires considerable improvement from most candidates. Candidates often quoted technical terms, but their answers lacked coherence. It is vital that candidates spend a little more time scrutinising questions before putting their thoughts on paper. Candidates can easily maximise their marks by using bullet points to demonstrate their understanding of physics. All candidates, irrespective of their final grades, need to learn their definitions. A definition can either be in the form of an equation with all terms clearly defined or textual. For example, the capacitance of a capacitor can either be defined as '*charge*/*p.d.*' or '*charge stored per unit p.d.*'; both are equivalent. In future, examiners will be looking for precision and clarity in all definitions.

All examination scripts are electronically scanned before being marked by examiners. Most candidates wrote their answers within the scanned zones for each question. A disappointing number of candidates were either writing their answers on separate answer sheets instead of the additional pages provided at the end of the question papers or not signposting where their supplementary answers were written. Examiners once again reported problems with poor handwriting and undecipherable answers from a small, but growing number of candidates; this is a regrettable trend.

Most Centres did well to prepare their students for the assessment of the practical skills. Overall the moderation of Centres was better with clearer annotation where marks have been awarded. The standard of work is gradually improving. Centres are reminded not to discuss any of the tasks or mark schemes with their students. There are still a significant number of Centres who have been scaled by large amounts.

As always, experienced teams of assessors provided accurate and efficient marking of the theory papers. On-screen marking of the papers allowed analysis of the performance of the papers at a question-by-question level. The Principal Examiners' reports reflect this detailed analysis.

The report for each unit of the June 2012 examination is given on the next page.

News round-up for GCE Physics A

A level reform

Over the last year, the future of A levels has received extensive interest. Ofqual is currently running a consultation to seek views from higher education, employers, learned societies, colleges, schools and others.

There is a link to all the relevant consultations, debates and reports at http://social.ocr.org.uk/groups/science/conversations/level-questionnaire-and-level-reform (also see http://social.ocr.org.uk/groups/science/conversations/level-timelines). We would strongly encourage teachers to contribute to the consultation (11 September deadline).

Additionally, if you have suggestions of content you would like to see in any revised GCE Physics qualifications please e-mail your comments to GCEScienceTasks@ocr.org.uk, we would be very happy to hear from you.

Keep up-to-date with developments in GCE Physics

- The OCR community, www.social.ocr.org.uk/groups/science, is a useful reference point to help keep teachers up-to-date with GCE Physics (and science). I would strongly recommend visiting the site and registering.

G481 Mechanics

General Comments

The marks for this paper ranged from 0 to 60 and the mean score was about 35. Most candidates made good use of their time and the omission rate was once again very low.

Candidates generally demonstrated decent analytical skills and logically set out their solutions. Most candidates displayed their answers to the correct number of significant figures. A small, but growing number of candidates in the lower quartile incorrectly truncate their answers in mid-calculations. This was particularly noticed in Q3(d)(ii) with the intermediate value for the magnitude of the deceleration of the rider and sledge. This poor practice is illustrated below.

$$a = -\frac{15}{3.5} = -4.286\ \text{m s}^{-2}$$

$$\text{mass}\ m = \frac{510}{4.2} = 121\ \text{kg}$$

Candidates are advised not to truncate or round their intermediate numbers; they should instead use all the digits available on their calculators.

There was a slight decline in the standard of quoting definitions. A disappointing number of candidates defined the unit rather than the physical quantity. For example, when defining *power*, some candidates would define the *watt*. The quality of written answers was very much Centre-dependent. Most Centres had made good use of past papers, marking schemes and examiners' reports. A small, but disturbing number of candidates struggled with their extended writing. Their answers lacked structure, reasoning and were often riddled with contradictions. For example in Q6(a), describing material Y as '*being elastic but also has some plastic behaviour and when unloaded it does not return to its original length'.* Once again, some candidates are reminded that marks cannot be awarded if examiners cannot decipher their poor writing.

In this paper, two marks were reserved in Q4(a)(ii) and Q6(a) for correctly using and spelling two technical words; most candidates secured both marks.

There were some very good scripts with clearly laid out physics and well presented calculations. The comments that follow tend to relate mainly to the opportunities that were missed by the candidates

Comments on Individual Questions

Question 1

Most candidates made a good start in this opening question and scored five or more marks. Candidates generally demonstrated a decent knowledge of physical quantities, units and prefixes.

(a) The majority of candidates were familiar with the idea that vector quantities have direction. The answers were precise and worthy of a mark.

(b) **(i)** Most candidates plucked out '*acceleration'* as the quantity incorrectly listed by the student as a scalar. The most popular incorrect response was '*time*'.

(b) (ii) This was a well answered question by most candidates. A disappointing number of candidates in the lower quartile could not identify '*energy'* and '*power'* from the list as the two quantities incorrectly listed by the student as vectors. The most frequently incorrect combination was '*energy* and *weight'*.

(b) (iii) About three quarters of the candidates correctly identified '*pressure'* and '*stress'* as the two quantities that shared the same unit. A disturbing number of candidates lost a mark for misquoting the unit for pressure and stress as N m^{-1}. Inevitably, there were strange combinations such as pressure and volume.

(c) Many scripts were saturated with all the prefixes scribbled next to the question and the correct answer of 10^{12} circled. The most frequent incorrect answers were 10^9 and 10^{15}.

(d) About a third of the candidates lost a mark by failing to rearrange the prefixes in the correct order. The correct sequence 'p μ c k' was succinctly quoted by most of the candidates.

Question 2

This question on a projectile produced a range of marks and discriminated well.

(a) This question produced bizarre answers and illustrated all the misconceptions linked with projectiles. A disturbing number of candidates thought that the direction of the acceleration was '*upwards from A to B and then downwards from B to C*'. It was difficult to understand why some candidates wrote '9.8 m s^{-2}' or '*north-east'* as their answers. It was rare to find the correct answer of '*vertically downwards'*.

(b) This was a well answered question with most candidates correctly calculating the horizontal and vertical components of the initial velocity of the metal ball. A very small number of candidates failed to change the mode on their calculators from radians to degrees.

(c) A very small number of candidates gave correct answers. Most candidates gave '*energy lost as heat or sound'* as their explanation. Some candidates even tried to explain their reasoning by considering the horizontal component of the kinetic energy. Successful answers mainly came from the candidates in the upper quartile; the metal ball had a horizontal component of velocity at B.

(d) This was a challenging question; it required good knowledge of equations of uniform motion and projectiles. About half of the candidates opted for correct equation but spoilt their answers by substituting 24 m s^{-1} instead of 12 m s^{-1} for the initial vertical velocity of the metal ball. The solutions were often well presented and easy to follow. Less than one in ten candidates omitted this question.

Question 3

All candidates attempted this question and marks were scored covering the entire range. Most candidates scored 7 or more marks.

(a) Most candidates made a poor start with not being able to define velocity. About a third of the candidates gave perfect answers such as '*velocity is the rate of change of displacement'* or '*change in displacement divided by time*'. A disappointing number of candidates lost the mark for omitting the word '*change'* in the latter version. A significant number of candidates defined velocity as '*speed in a certain direction*'.

(b) Most candidates correctly defined work done by a force. An unexpectedly large number of candidates defined work done as '*force* × *perpendicular distance moved*'. Some candidates were too brief with the statement '*force* × *distance'* and consequently scored nothing.

(c) (i) This was well answered by candidates in the upper quartile. Only a small number of candidates realised that the force *N* did no work because the sledge was moving at right angles to this force. Many candidates made reference to the fact that the frictional force was zero so no work was done. A disappointing number of candidates thought that the question was something to do with drag and terminal velocity.

(c) (ii) The most common answer was '*gravity'* or '*weight*'. Some candidates referred to the **horizontal** component of the weight rather than the component of the weight down the icy slope. About a quarter of the candidates managed to secure a mark.

(d) (i) Most candidates correctly calculated acceleration of the sledge and rider from the gradient of the graph. The answers were generally well presented. A small number of candidates used a point on the line to determine the value of the acceleration. About one in five candidates successful determined the angle made by the slope to the horizontal using $mg\sin\theta = ma$ or simply $g\sin\theta = a$. A disappointing number of candidates inexplicably determined the angle made by the line on the graph of Fig. 3.2.

(d) (ii) The majority of candidates successfully used their knowledge of physics to calculate the mass of the sledge and rider. Almost three quarters of the candidates secured full marks for this question. Some candidates ignored the information given about the collision with the foam barrier and attempted to solve the problem using the data from (d)(i). A small number of candidates used '*impulse* = *change in momentum'* to calculate the total mass of the sledge and rider

Question 4

This was generally a well answered question with most candidates scoring more than four marks.

(a) (i) More than half of the candidates successfully gave a precise definition for a *couple*. The most common error was failing to mention that the forces were equal.

(a) (ii) Less than half of the candidates correctly defined torque of a couple. The most common mistake was to omit the key word '*perpendicular'* from the definition. Some candidates got muddled with the definition for a moment of a force. It was good to see that many candidates could correctly spell '*perpendicular'*.

(b) (i) Most candidates secured two marks by stating that the satellite '*would rotate in a clockwise direction'*. There were some serious misconceptions here too. For some candidates, the couple produces a '*zero net force, so the satellite would remain stationary*'. About a third of the candidates scored nothing for this question.

(b) (ii) The modal mark for this question was one, with the candidates either realising that the satellite would turn or accelerate towards the right. About a quarter of the candidates scored two marks.

Question 5

This was a well answered question with candidates showing good understanding of vector addition and factors affecting drag.

(a) It was a pleasure to see well structured answers for the calculation to find the net force acting on the balloon. Most candidates drew a vector triangle with a vertical force of 30 N. A small number of candidates extended their logic of vector addition by successfully drawing a polygon of forces. Some candidates determined the angle made by the resultant force with the vertical.

(b) Most candidates concisely stated two factors that affected the drag force on the balloon. A bald answer such as '*density*' could not be given credit because it was not clear whether this referred to the material of balloon or the surrounding air. The most frequent incorrect or vague factors were '*wind speed'*, '*size of the balloon'*, '*shape of the* balloon' and '*weight of the balloon'*.

Question 6

For the extended writing question on materials X and Y, brevity was often a sensible strategy because contradictions were avoided. Candidates opting for bullet points often did well. This question produced a range of marks and it too discriminated well.

(a) Most candidates correctly identified material X to be brittle and material Y to be polymeric. It was comforting that most candidates could correctly spell '*brittle'*. However, the variants for the spelling of '*polymeric'* are too numerous to mention. Most candidates realised that material X was elastic and showed no plastic properties. Unlike material Y, material X obeyed Hooke's law. Many candidates also correctly identified material Y to be elastic. Some even managed to recognise the heating effect caused by hysteresis. A disturbing number of candidates thought that material Y showed '*plastic behaviour and hence would be permanently deformed when unloaded'*.

(b) The modal mark for this question was two. Most candidates appreciated that the 100 g mass had to be attached to the spring and its extension determined using a ruler. Most candidates knew that they had to use the equation $k = \frac{F}{x}$. However, the force F was often incorrectly determined. The most popular incorrect values for F were 100 grams, 981 N and 0.1 N. Some candidates simply stated that '*F is the weight attached*' without further clarification. A small number of candidates totally ignored the question asked and decided to plot a graph of force against extension using a single mass of 100 g.

(c) (i) Most candidates were able to correctly calculate the acceleration of the glider. The most common error was to use value of the force constant as the maximum force. This gave an incorrect answer of 278 m s^{-2}. About a third of the candidates scored no marks for this question.

(c) (ii) Many candidates struggled to communicate the correct physics for this question. A disappointing number of candidates used '3.5 × 0.070' instead of '½ × 3.5 × 0.070' to calculate the work done on the spring. A small number of candidates desperately tried using the equations of motion to determine the distance travelled by the glider during acceleration; failing to realise that 0.070 m was already given in the question.

Question 7

Most candidates scored five or more marks for this question. A good number of candidates in the upper quartile demonstrated their superb analytical skills in (d).

(a) Most candidates did manage to score a mark by correctly defining power. Predictably, a small number of candidates defined the *watt*. It seems that learning definitions is a problem for a significant number of candidates across the ability spectrum. It is regrettable that a third of the candidates could not define power.

(b) This was a well answered question with most candidates correctly substituting values into the kinetic energy equation.

(c) Most candidates effortlessly determined the efficiency of each turbine to be 27%.

(d) This was a tough question, omitted by about one in ten candidates. A fair number of candidates managed to get as far as determining the volume of water passing though the turbine per second. The answer of 942 $m^3 s^{-1}$ was sprinkled on many of the scripts. Thereafter, for many candidates, the physics fell apart. Many candidates could not identify the correct volume equation. About a third of the candidates, mainly in the upper quartile, identified the volume per second to be '$3 \times \pi r^2$'. This gave them a correct value for the radius as 10 m.

(e) **(i)** A pleasing number of candidates realised that water has a greater density than air. Some candidates thought that the tidal stream turbine system would produce greater power because '*they have two turbines'*.

(e) **(ii)** Most candidates secured a mark for this final question by citing one of the environmental benefits of the tidal stream turbine systems.

G482 Electrons, Waves and Photons

General Comments

These scripts represented a wide range from excellent answers which displayed a depth of understanding and conciseness in presentation to weak ones showing many gaps in knowledge and application. While many were able to express their ideas succinctly there was a considerable degree of woolly thinking and many candidates failed to gain marks through careless writing of definitions. A particular example was the use of the word “amount” when either “number” or “distance” should have been used in the context of the question. Many answers would have been improved following from a more thorough reading of the question.

Candidates scored well in the first and second questions which gave a good introduction, easing them into the paper. Question 3 produced a more even distribution of marks, as some candidates’ powers of description and of observation were more challenged. Question 4, on an electric circuit, scored well. The calculations in Question 5 about electrons and photons scored better than the descriptive sections. It was surprising that a substantial number of candidates did not know the difference between a photon and a proton. The final section was answered well by only the best candidates. Question 6, about waves, proved to be a good discriminator especially the solution of a practical problem in the last section. Question 7, on hydrogen spectra, and Question 8, on the electromagnetic spectrum, both discriminated well and good candidates were able to demonstrate their knowledge and understanding.

The large majority of candidates had adequate time to complete the paper and few left any but the hardest sections of the paper un-attempted. A few scripts gave examiners difficulties in interpretation, as a result of poor handwriting.

Comments on Individual Questions

Question 1

(a) Fewer than 50% of candidates gave precise definitions. Common errors were the lack of indication of transfer of energy and the inclusion of the time element twice giving “rate per second”. Other answers offered a specific electrical example rather than a general definition.

(b)(i) & **(ii)** These calculations were well done with relatively few errors.

(c) The majority of answers were correct; some weaker candidates had difficulty in manipulating the equation given in the data sheet.

(d) The best answers argued that an increase in power at constant voltage indicated an increase in current, hence a decrease in resistance, and hence an increase in area of cross-section. Some calculated all the values to illustrate the point. Many weaker candidates chose to increase the thickness to stop the filament from melting with the larger current.

(e) **(i)** The majority reached the correct answer; some by a lengthy method repeating calculations from previous parts.

(e) **(ii)** Better candidates knew that the kWh is a unit of energy rather than power. Common errors in calculating the cost arose from putting the time in seconds rather than hours and from incorrect powers of 10.

Question 2

(a) (i) The value for the first resistance was evenly divided zero and infinity; some candidates gave both. A common error for the second resistance was to fail to notice the scale unit on the current axis.

(a) (ii) This question was a good discriminator. Most good candidates were not misled into relating the gradient of the linear section of the graph to a constant resistance. There were many contradictory statements made. Another common reason for the resistance of the LED decreasing was an imagined increase in temperature with current.

(b) This section discriminated well. The symbol for an LED was the least well-known component of the circuit but even the weakest candidates managed to place the resistor correctly. Many had no realisation that the orientation of the symbol relative to the connecting wires is important.

(c) This section was answered well though a few answers omitted the requested example.

Question 3

(a) Many answers included the phrase "as the thermistor is heated, the resistance decreases" without saying that this change in resistance refers to the thermistor and hence to the total resistance of the circuit. Candidates also failed to gain a mark if they did not state the equation $V = IR$, when explaining why the current rises. Only the better candidates indicated that V referred to the supply and R to the total resistance.

(b) Some incorrectly read the value of resistance from the graph; usually giving 20 ohm rather than 40 ohm but thereafter completed the calculation correctly, being given full credit for the rest of their answer.

(c) (i) More than half the candidates were able to draw a correct symbol for the LDR. Incorrect attempts varied from a variation of the LED symbol to a variable resistor.

(c) (ii) To avoid credit being given to ambiguous answers, it was necessary for candidates to state that the resistance of the LDR decreased or that the current in the circuit increased to score any marks.

Question 4

(a) To score marks candidates needed to state that resistors in parallel have the same voltage across them or that the current splits in the inverse ratio of the resistances. Many candidates failed to observe the request to explain their answer and relied solely on a calculation, failing to gain any credit.

(b)(i) & **(ii)** Were well answered.

(c) (i) All but the weakest candidates, who were usually unable to add reciprocals correctly, gained full marks.

(d) (i) Explanations of the term e.m.f. often either omitted the fact that energy was transferred from another form into electrical energy or failed to state per unit charge.

(d) (ii) Just over half the candidates correctly derived the given value. The others attempted to manipulate the available data to try to reach it.

(d) (iii) Again about half of the candidates calculated the correct value. Confusions arose from using the wrong current or between the values of e.m.f and terminal p.d.

Question 5

(a) The question asking for two differences between the properties of electrons and photons was poorly answered. Many candidates offered properties of one without comparison with the other. Many confused photon with proton.

(b) (i) This section was well answered.

(b) (ii) About half the candidates knew that they could derive speed from the given value of KE. A few of these failed to show full evidence of their calculation and so failed to score full marks.

(c) Just over one third of candidates knew that the electron's wavelength depends on its speed/momentum. Many more were able to use the equation to calculate the value.

(d) Candidates have obviously been well drilled in performing calculations like this one. Few failed to obtain the expected answer.

(e) (i) The large majority of candidates correctly identified photoelectric emission. Others offered some curious alternatives.

(e) (ii) A well-answered section.

(e) (iii) Only the most able candidates had sufficient understanding of the process to be able to explain why the KE of the emitted electron cannot be greater than the value calculated in (e)(ii).

Question 6

(a) (i) The majority of candidates could define amplitude but many struggled to define displacement, frequently omitting that it applied to a point or particle on the wave.

(a) (ii) Correct definitions of frequency outnumbered those of phase difference; many candidates losing marks on the latter when they confused it with path difference. About half failed to score for either.

(b) This section discriminated well. Common errors on partially correct drawings were the failure to reverse the shape, the realisation that there is no displacement for the first 0.5 s and the inclusion of extra loops.

Question 7

(a) (i) The successful candidates read the question carefully and explained both why there are 3 possible transitions and also why this leads to emission of radiation. Some were unsure of the direction on the diagram in which electrons move for emission of energy.

(a) (ii) Calculation of the energy of the photon was done well but the failure of many to identify the correct transition indicated the lack of understanding.

(b) (i) The majority of candidates scored well on this section. Errors arose in finding the number of lines either through failing to take the reciprocal or neglecting the units and incurring a power of 10 error.

(b) (ii) Only one third of candidates realised that blue rays would leave the grating at a smaller angle than red rays and correctly drew in both rays as requested.

Question 8

(a) The most common properties suggested were that e.m. waves can travel at the speed of light and in a vacuum. Many answers then included a property, such as the transverse nature of e.m. waves, which is <u>not</u> an exclusive property, as required by the question.

(b) This section was very well answered.

(c) (i) Successful candidates read this section carefully and confined their discussion to the two signals arriving at the transmitter, rather than the effect of these signals on each other. Most identified the signals and explained why they had the same frequency but many failed to realise that the difference in amplitude arises from the distances travelled and not as a result of the reflection.

(c) (ii) There were some good answers to this section but others failed to gain marks through imprecise or incomplete descriptions. There is still considerable confusion, mixing path and phase differences together in phrases such as ‘a phase difference of n wavelengths’.

(c) (iii) Only a quarter of candidates realised that, in a standing wave, the distance between adjacent maxima and minima is one quarter of a wavelength.

(c) (iv) This section was completed correctly only by the best candidates. Many knew the relationship between amplitude and intensity but then squared the amplitudes before adding, rather than finding the resultant amplitude first.

G483/01 Practical Skills in Physics 1

General Comments

The assessment of practical skills relies very much on the care and attention to detail that the individual Centres put into the process. Again the majority of Centres approached the organisation of the tasks well and candidates appear to have been suitably prepared. There were no major issues with the apparatus required to carry out the tasks. Centres are thanked again for the valuable contribution that they have made in making this unit of assessment successful.

Centres are advised to check that they are using the latest assessment material from ‘Interchange’. Before marking a task, ‘Interchange’ should be checked. Centres are advised to sign-up to the email update process.

Centres are required to submit one type of each task for each candidate. Where Centres submitted more than one task of each type, moderators are required to return the whole sample to the Centre.

One of the purposes of the moderation process is to confirm the marks awarded by a Centre. It is thus very helpful where a Centre has annotated the script either to justify the award of a mark or to indicate why a mark has not been awarded. It was clear from the moderation process that the majority of Centres marked the tasks carefully and it was pleasing to see many helpful annotations. Centres are encouraged when marking B1.2 in the Qualitative Tasks and C4.1 and C4.2 in the Evaluative Tasks to include the numerical marking point as well, e.g. C4.1-2 for the second marking point for C4.1.

Centres are reminded that candidates should complete the tasks in black (or blue) pen using pencil for graphs and that marking should be carried out in red pen. It was clear that the majority of larger Centres had carried out appropriate internal moderation. Centres must ensure that the marks awarded are clearly indicated on the scripts. Furthermore, where marks have been changed as a result of the internal moderation process, the MS1 is completed with the agreed Centre mark.

Another purpose of the moderation process is to ensure consistency between Centres and thus it is essential that the mark schemes provided are followed. Centres are asked to use the marking boxes provided on the tasks so that the moderators are aware of which marks have been awarded. The questions at the end of the Qualitative Tasks and the Evaluative Tasks are ‘high demand’ questions and thus Centres should not credit trivial answers. Additional guidance is given in the mark schemes and Centres are welcome to contact OCR for further guidance. Centres need to be careful about giving ‘benefit of doubt’ marks. If a Centre is to award a mark which is ‘benefit of doubt’ then the script must be annotated with reasoning. The same candidate should not then be awarded another benefit of doubt mark.

Candidates should be reminded of the need to show all the steps clearly when carrying out calculations; this particularly applies to the end of the quantitative tasks and when determining uncertainties in gradients or *y*-intercepts in the evaluative tasks. In addition, candidates should be encouraged to include greater detail in their answers to descriptive type questions, giving reasons where necessary.

Centres are reminded that the only help to be given to candidates is clearly indicated in the ‘instructions for teachers’. Any help given must be recorded on the front of the appropriate task. Under no circumstances should help be given in the construction of the table of results, the graph or the analysis parts of the quantitative tasks. Centres must ensure that the guidance within marks schemes remains confidential at all times.

The Practical Skills Handbook (available from the OCR website) is a useful document for both the preparation of candidates and the marking of the tasks.

Administration

There were still arithmetic/transcriptions errors with marks. There are three different ways of these errors occurring:

1 Inaccurate completion of the MS1 or equivalent. It is good practice for Centres to ensure that there is a suitable procedure for checking the compilation of marks.

2 Adding up of the three tasks. A large number of Centres successfully used the spreadsheet which is available on "interchange" to assist the process. Centres are advised to use both the spreadsheet and the cover sheet.

3 Incorrectly filling in the mark boxes (particularly A2.3, B2.3, C1.3 which are only worth one mark and were often credited with two.

A number of Centres did not always follow the rule on resubmitting tasks correctly. As the 'Frequently Asked Questions' on 'Interchange' indicates, candidates wishing to improve their mark by re-sitting this unit can re-submit one or two Tasks (from any of the Qualitative, Quantitative or Evaluative Tasks) plus one (or two) of the new available Tasks **OR** complete three new Tasks (from the selection available for assessment on Interchange clearly marked with the current assessment year). When a candidate re-sits this unit and uses up to two tasks from the previous session, the marks confirmed by the original Moderator in the previous session cannot be 'carried forward'. Teachers may re-mark the Task in light of any comments made by the original Moderator (the Archive Mark Schemes are available on Interchange for this purpose) and it will be re-moderated when it is re-submitted. Thus the Centre must include one Qualitative, one Quantitative and one Evaluative Task for each candidate in the sample. It is important that Centres review their procedures with regard to storing the work for next year. Furthermore the re-submitted tasks should be reviewed in the light of the moderator comments. Where a candidate has not made any improvements to their marks on a 'new' task, they should not be entered (or if they have been entered, they must be withdrawn). Centres should ensure that the candidate number is the same on each piece of work that is submitted. The Cover sheet also allows for additional information to be given to the moderator, for example indicating that a task was previously submitted.

Centres should ensure that the marks are submitted to OCR and the moderator by 15th May. Small Centres should also submit all their candidates' work in line with the moderation instructions directly to the moderator and not wait to hear from the moderator. Larger Centres should wait for the automated email from OCR. If a Centre has not heard from OCR by the end of May then the OCR Contact Centre should be either telephoned or emailed. Where work is submitted late, the candidates' marks may not be ready for the publication of results.

It was very helpful where Centres enclosed with their paperwork any correspondence with OCR including copies of emails and coursework consultancies. About two thirds of Centres included a sample set of results together with any details of any modification to the tasks. This is very helpful and it is hoped that all Centres will supply the sample results in future.

Finally it is essential the Centre Authentication Form is completed and sent to the moderator. Moderators had to ask a small number of Centres to supply this form. Copies of this form are available from the OCR website.

Centres should receive an individual report from the moderator. This will be available from interchange – the Centre's Examination Officer should be able to access the report.

Qualitative Tasks

Generally Centres marked these tasks accurately.

For B1.2 Centres are able to award one mark for “other detailed correct statement that supports the observations”. Where Centres are unsure as to whether the mark should be awarded, clarification should be sought from OCR.

Where candidates are asked to describe an experiment, the description should include how the variables are to be manipulated as indicated in the additional guidance of the mark scheme. Likewise additional method marks (A1.2) must be detailed – vague answers should not be credited.

Where graphical work is requested in the Qualitative Tasks, candidates are not being assessed on the size of the graph or the labelling of the scales since this is assessed in the Quantitative Tasks. The graph may be used to judge the quality of an experiment. In addition, candidates may be assessed on their drawing of a straight line of best-fit or a smooth curve. This latter marking point was again generously awarded. There should be a balance of points about the line and ‘hairy’ lines should be penalised. Further guidance is given in the Practical Skills Handbook.

B1.2 is still generously marked; candidates’ answers must be detailed and explanations must be thorough – the guidance given the mark scheme should be followed. It is very helpful to indicate where the mark is awarded with an indication to the corresponding point in the additional guidance. Again Centres are always welcome to email OCR for further guidance.

Quantitative Tasks

The mark schemes for the quantitative tasks are generic in nature and very much reflect good practical skills which candidates should develop throughout the course. It was noted that in some larger Centres, there was inconsistency in the marking of these tasks by different teachers.

Centres are able to help candidates in setting up the apparatus (as indicated in the mark schemes), any help given must be recorded in the box on the front of the Task. Under no circumstances may Centres assist candidates in the construction of graphs or in the analysis section. Most candidates were able to set up the apparatus in the tasks without help. Centres that did provide help clearly indicated it; this was very helpful to the moderation process.

Results tables were generally well presented. The majority of candidates labelled the columns with both a quantity and the appropriate unit although weaker candidates often did not score this mark with the more complicated units. It is expected that there should be a distinguishing mark between the quantity and the unit. Index notation should be encouraged, e.g. $1/t^2$ / s^{-2} or t^{-2} / s^{-2} is encouraged.

All raw data should be included in a table of results and given consistently. Common errors in this part were to have inconsistent readings e.g. distances not measured to the nearest millimetre when using a metre rule or not to use a suitable full range. Often candidates recorded distances to the nearest centimetre although a small number added zeros so as to indicate that they had measured distances to the nearest 0.1 mm. When significant figures are assessed in the table, the guidance in the mark schemes must be followed. Candidates still appeared to be confused regarding the difference between decimal places and significant figures.

Graphical work was generally done well. When a candidate asks for another sheet of graph paper, a similar sheet should be issued. Weaker candidates often used less than half of the graph grid for their points. On the graph paper provided, it is expected that the points should occupy four large squares horizontally and six large squares vertically. Points were usually plotted accurately to within half a square. Often mis-plotted points were very obviously wrong; candidates should be encouraged to check points like this as they finish plotting graphs. The mark schemes very clearly state that "two suspect plots" should be checked and that these plots must be circled. The majority of candidates drew their line of best-fit with a fair balance of points. For the award of this mark there must be at least five trend plots.

Candidates will normally need to determine the gradient and/or the *y*-intercept of their line of best fit. It is expected that the gradient should be calculated from points on their best-fit line which are at least half the length of their line apart. Weaker candidates often lost marks either by using triangles that were too small or by working out $\Delta x/\Delta y$. Good candidates indicate clearly the points that they have used and show their calculation. The plots selected must be accurate within half a small square and the calculation must be checked. Where candidates are not able to read off the *y*-intercept directly, it is expected that they should substitute a point on their line into the equation $y = mx + c$. Guidance is clearly given in the Practical Skills Handbook. Gradient/*y*-intercept values do not need units. Centres are asked to ignore both incorrect units and significant figures at this stage – candidates will invariably be penalised in C2.2.

Candidates are then required to use either their gradient or their *y*-intercept to determine another quantity. It is essential that candidates show their working. Often for C2.1, the first mark is given for equating the gradient or *y*-intercept correctly; the second mark determining a value for the quantity using their particular values for the gradient and/or *y*-intercept. At this stage candidates are not usually penalised for a power of ten error or indeed if a mistake has been made in determining the gradient or *y*-intercept. The C2.2 marks are awarded for candidates who have used the gradient/*y*-intercept and given their answer to an appropriate number of significant figures and the second mark is awarded for the quantity being within a specified range with a consistent unit having used the gradient/*y*-intercept. It is at this stage that a power of ten (POT) error would be penalised. For example, a candidate determining the acceleration of free fall, *g*, the mark scheme may say allow 9.00 ms^{-2} to 11.0 ms^{-2}. If this was the case a candidate who calculated *g* correctly for C2.1 for two marks having arrived at a numerical answer correctly using the equation given, would score one mark for C2.2 for an answer of 970 ms^{-2} or 971 ms^{-2} (since there is a power of ten error but the number of significant figures in both cases is appropriate). Candidates who do not use their gradient and/or *y*-intercept values cannot score C2.2 marks.

The final mark for the quantitative task (C2.3) is awarded for justifying the number of significant figures. The phrase "raw data" is not explicit enough; candidates must explicitly quote the quantities that have actually been used. Thus, where a candidate states "I quoted my answer to 2 significant figures because that was the least number of significant figures in my data", the mark should not be awarded.

Evaluative Tasks

Again the Evaluative Tasks were where weak candidates had greatest difficulty. There are a large number of high demand marks in these tasks and Centres should not give credit for weak or vague answers. It is important that the additional guidance in the mark schemes is carefully followed

The initial part of the task requires candidates to determine percentage uncertainties. When marking this part, significant figures should not be penalised. Centres were sometimes generously awarding the uncertainty in a measurement; it is important that the mark scheme is applied consistently.

Where candidates are asked to determine a percentage uncertainty in a quantity requiring the use of the gradient and/or *y*-intercept then the worst acceptable line should be drawn. In many cases, the worst acceptable line was generously credited for lines which often did not follow the original trend. As the Practical Skills Handbook indicates, candidates do not need to use error bars. It is expected that candidates will correctly determine the gradient and *y*-intercept correctly for the award of this mark; small triangles and incorrect read-offs should be penalised.

In C3.2, there continues to be confusion between the terms *accuracy* and *reliability*. A number of Centres were generous in awarding marks for a single sentence with ambiguous phrasing. It is suggested that candidates be encouraged to approach each term independently and allotting each a separate sentence. When candidates are discussing reliability they are expected to make a relevant point regarding the scatter of points about the straight line of best-fit. For the award of the accuracy comments such as “it is close to the accepted value” is not good enough for a mark – the answer needs to be more detailed with reference to the percentage uncertainty determined earlier.

For C4.1 and C4.2, the mark schemes allow for “one other <u>detailed</u> correctly identified limitation” and a corresponding improvement to this limitation. Centres should ensure that they credit detailed answers at this stage. Again it was most helpful where Centres annotated the work with the actual marking point awarded e.g. C4.1 – 3 for the third limitation point.

Weak candidates are still often describing the procedure they followed. Some candidates wrote very little of substance. Good candidates scored well by describing relevant problems and suggesting specific ways to overcome them. Vague suggestions without explanation did not gain credit. In particular ‘light gates’ without explanation must not be awarded; detail is needed. Likewise a “parallax” without explanation should not be credited. Centres should ensure that they follow the mark schemes carefully. Centres should not be awarding ‘benefit of doubt marks’. If a Centre wishes to gain further clarification then advice should be sought either by both email or by using the coursework consultancy service.

In Evaluative Task 2 this year for C4.1, the additional guidance stated that “one limitation <u>must</u> be either 1 or 2. The following table indicates how this statement should be applied:

Limitations included	Marks Awarded
1 only	1
2 only	1
1 and 2	2
1 or 2 and 3	2
1 or 2 and 4	2
3 or 4 only	1
3 and 4	1

The last part of each Evaluative Task (C4.3) requires candidates to identify one source of uncertainty and indicate the likely effect that this uncertainty would have on the quantity determined. Candidates should use a step-by-step approach and include the effect on the gradient and/or *y*-intercept. The reasoning by candidates must be consistent and correct for the award of this mark. Vague answers should not be credited.

Finally

Centres are always welcome to email OCR for clarification about the interpretation of a particular marking point. There is also a coursework consultancy service available – further information is available from ‘Interchange’. It would be helpful if Centres could submit coursework consultancies as they mark the tasks and preferably by the end of the Spring term so that feedback can be given in good time before the 15th May deadline.

Finally this year's and the previous years' tasks, instructions and mark schemes continue to remain confidential. Furthermore candidates' work from this year (and previous years) also continues to remain confidential. If there is a possibility of a candidate re-submitting the work, then the Centre must keep the work securely, otherwise the work should be destroyed securely in line with OCR's policy for controlled assessment.

G484 The Newtonian World

General Comments

There were very few omissions this session and it is good to report that all candidates were able to attempt to answer the majority of questions on the paper. This suggests that candidates had adequate time to read questions carefully and complete their answers. There were plenty of opportunities for good candidates to demonstrate their knowledge on the many topics covered on the paper. Weaker candidates were able to attempt most questions and were able to maintain their confidence resulting in marks being scored over the entire paper.

The standard of work varied from very good to weak, particularly in questions involving extended writing. Generally the mathematical solutions were well structured. However, a minority of candidates appear to be unaware of the importance of showing all the stages in their working for questions that include a ‘show that’ component.

One regrettable feature of candidates’ work this session was the number of scripts with very poor handwriting. In many cases this made it difficult for examiners to reward the candidates for their work.

Candidates could have scored more marks by learning the definitions of quantities and the laws more precisely. For example only about 20% scored the mark for the definition of *impulse* and over one third were unable to state Newton’s law of gravitation accurately.

There were some very good scripts with clearly laid out physics and well presented calculations. The comments that follow tend to relate mainly to the opportunities that were missed by the candidates.

Comments on Specific Questions

Question 1

(a) It was somewhat surprising to see such a wide range of answers to this straightforward opening question. Many candidates gave statements approximating to Newton’s first and second laws without relating them to the context of the question. However, only the weakest candidates failed to obtain the mark somewhere within their answer.

(b) (i) This question was very poorly answered by the majority of candidates. The most common error seen was to define impulse as the change of momentum (rather than force × time for which the force acts). Whilst this is a valid relationship, it is not the defining equation and consequently no credit was given. Many candidates did not fully define the time in the correct defining expression and also lost the mark. At A2 level definitions and laws should be precisely stated.

(b) (ii) This proved to be a discriminating question. Many recognised the significance of the area under the graph, but failed to score the second mark by not making '*v*' the subject of their final equation.

A significant minority did not appreciate that it was not appropriate to use constant acceleration formulae such as $v = u + at$ in this situation and failed to gain any credit.

(c) (i) Apart from a small minority who managed to confuse the velocities given in the question, this calculation was well answered.

(c) (ii) There were many well structured answers to this question using either of the expected routes, which was very pleasing.

(c) (iii) The majority of candidates found this question to be extremely difficult. Very few even mentioned the player holding the racket and only a small fraction of those candidates recognised that the player would make a contribution to the momentum.

Many answers centred on the effect of air resistance indicating that the candidates had not fully appreciated the information given in the question.

Question 2

(a) Following the comments made in June 2011 Report it was pleasing to note the improvement in the understanding of SHM. The definition was generally well understood by candidates and only the weakest candidates failed to score full marks.

(b) (i) This calculation caused little difficulty to candidates although a small minority quoted their answer to 1 sf apparently confusing decimal places and significant figures.

(b) (ii) Only the most able candidates were able to score marks on this question. Over half of those managing to gain some credit could complete the calculation correctly but were unable to explain their method. The first mark in the mark scheme was rarely awarded even to the most able candidates and there was much confusion in the minds of candidates between forces and accelerations. Many seemed to be equating acceleration with velocity which was worrying at this level. Many of the answers referred to resonance conditions.

(c) (i) The phenomenon of resonance was well known and generally well explained by candidates. A small number failed to gain the second mark because they could not clearly distinguish between the driving oscillation and the driven oscillation. This important distinction needs to be emphasised in the teaching of this topic if candidates are to give convincing answers to questions on this topic.

(c) (ii) This question was poorly answered largely as a result of careless drawing. Very few scripts had the peak of the graph at higher amplitude and hence were able to score one of the accuracy marks. All too often candidates failed to draw in a guiding vertical line through the given peak. This simple device would have made it much easier for them to locate their own peak correctly. Many candidates lost the second mark because the curves touched at the high frequency end. The requirement for the candidate's graph to be below the given graph was relaxed at the low frequency end but not at high frequency.

Candidates do not appear to have recognised that the instruction to "sketch" a graph at this level implies a need for accurate location of the salient features of the curve.

A significant number of candidates failed to follow the instructions given in the question and drew a separate graph. Since they did not repeat the original curve on their graph it was impossible to assess any of the criteria and unfortunately no credit could be given.

Question 3

(a) (i) Almost all candidates correctly drew a labelled arrow, either on the string, or at right angles to the tube as required.

(a) (ii) The answers to this question were mostly disappointing. Less than half of the candidates stated that the force was at right angles to the velocity of the bung and very few were able to conclude that this implied no work was done by F.

(b) (i) This question was poorly answered by the majority of candidates and it was rare to award more than three marks. More often than not candidates did not clarify how they would measure the radius and did not state the importance of keeping it constant. Many lost a mark for not determining an average value for the period of the rotation. The majority of candidates misunderstood the purpose of the experiment and proceeded to use the formula $F = mv^2/r$ to determine F. A small number of candidates recognised the need to use the weight of the slotted mass but could not be given the credit since they did not indicate that they were aware of the formula required to obtain that value.

Given the fact that five marks were available for this description it was surprising to see so many answers with only two or three lines of text.

(b) (ii) In general the graphs drawn were linear but a minority of candidates drew curves and so lost two marks at least. Many suggested that as the radius was constant it could be ignored. A significant number of candidates gave answers which did not even refer to the graph and consequently were rarely able to be given any credit.

(a) (i) It has long been recognised that definitions of quantities should involve quantities themselves and not be dependent on the unit system in operation. However, this particular definition is not particularly easy to write and the examiners decided to relax this condition to the extent that they would ignore references to kg and K provided that it was clearly stated that unit <u>mass</u> and unit <u>temperature</u> changes were required. The clearest responses to gain credit here were those given by candidates who quoted a defining equation, either in words or symbols with stated meanings. Such an equation should, of course, have specific heat capacity as the subject.

(a) (ii) This was another question testing a fairly basic concept which seemed to cause some difficulty to candidates. Many lost the mark by implying that latent heat was a process rather than a form of thermal energy.

(b) (i) It was apparent from the answers to this question that candidates had not given much thought to the concept of internal energy in solid and liquids. The key to this topic is the curve relating the force between molecules to their separation and its associated energy graph. Few candidates realised that increasing the vibration of the molecules would cause a small increase in the potential energy of the molecules as a direct result of the asymmetric nature of the force. Consequently many were unable to score the stretch and challenge mark for the A to B section. Answers to the B to C section were much better, although some candidates erroneously concluded that the potential energy increase caused the kinetic energy to decrease. A significant number of candidates failed to answer the question thoroughly by only making reference to one form of energy in each section.

(b) (ii) Answers to this question were better than expected although candidates did experience some difficulty in expressing their ideas fluently.

(c) (i) This calculation was particularly well done with few errors.

(c) (ii) Only a few candidates gave the expected answers. Most wrote about heat loss in pipework or the showerhead.

Question 4

(a) This question caused little difficulty although a few answers were somewhat ambiguous as a result of the overuse of 'they' rather than naming the objects clearly.

(b) (i) Well answered by most candidates.

(b) (ii) Another straight forward calculation well answered by all but a few.

(b) (iii) The answers to this question indicated a very superficial understanding of this topic. Too many candidates linked more frequent collisions between gas molecules with a rise in temperature, whilst those who did mention collisions with the piston were less than precise in their subsequent link to temperature changes.

Question 5

(a) (i) Many candidates struggled with the wording of this law and would perhaps be better learning a defining word equation.

(a) (ii) This definition was accurately given in terms of quantities by the majority of candidates.

(b) Both calculations in this part were accurately performed and on the whole clearly set out. A minority, however, omitted to show the substitution in the 'show' question (ii) and unnecessarily lost one mark.

(c) This high demand question caused many candidates difficulty although the need to use the Kepler relationship between T and R was generally recognised. Candidates still appear to find ratio questions difficult to answer.

G485 Fields, Particles and Frontiers of Physics

General Comments

The marks for this paper ranged from 0 to 98 and the mean score was around 60. Most candidates were able to complete the paper on time and had attempted every question on the paper.

The standard of work from the candidates was much better than last year. Candidates were much more thoughtful and methodical when presenting analytical answers. Most candidates coped extremely well with algebra and logarithms. The solutions were often well presented and the final answers written to the correct number of significant figures. Candidates are once again reminded that there are no marks for substituting values into an incorrect equation. The quality of written answers was very much Centre-dependent. Many candidates had rote learnt important words such as '*precession'* and '*relaxation times'* without having deeper understanding. Consequently, their answers were often muddled and rife with misconceptions. Some candidates would have benefited by writing their answers in bullet points rather than in continuous prose. There were some very good scripts with clearly laid out physics and well presented calculations.

Comments on Specific Questions

Question 1

(a) Most candidates successfully defined the farad as '*coulomb per volt'*. A significant number of candidates gave the definition for both capacitance and the farad and expected the examiner to choose the right answer. A significant number of candidates gave incorrect definitions with mixed units and quantities. Answers such as '*charge per volt'* and '*coulomb of charge per voltage'* were quite prevalent. Some candidates totally forgot the ratio aspect of the definition.

(b) (i) More than half of the candidates failed to recognise the gradient of the graph was the reciprocal of capacitance. The most common incorrect answer was '*capacitance'*, followed by '*energy*' and '*current*'.

(b) (ii) Almost all candidates recognised the area under the graph to be work done or energy. A small number of candidates got the answers for (b)(i) and (b)(ii) muddled.

(c) More than half of the candidates correctly drew three labelled capacitors in series and correctly calculated the total capacitance as 59 μF. The calculations were generally well-presented with most candidates working in microfarads. Some candidates drew a parallel circuit and lost a mark. A disturbing number of candidates drew the resistor symbol for a capacitor. A small number of candidates, mainly in the upper quartile, drew both series and parallel circuits and did calculations for both circuits. A small minority thought that the third capacitor had a capacitance of 300 μF.

(d) (i) Almost all candidates scored full marks for calculating the charge stored by the capacitor. Only a small number of candidates ignored the milli prefix for the current. In spite of the capacitor being charged at a constant rate, a small number of candidates tried answering the question using the concept of time constant.

(d) (ii) Most candidates secured full marks for the energy stored by the capacitor. A small number of candidates used capacitance values from (c) rather than 0.10 F.

Question 2

(a) (i) With very few exceptions, candidates drew an arrow from point A directed towards the centre of the circular track.

(a) (ii) Less than half of the candidates realised that no work was done on the electron because the force was perpendicular to the velocity. A significant number of candidates thought that no work was done because it was a uniform magnetic field. Some of the answers were simply too vague; these included '*force was right angles to the direction of the electron*' and '*force was perpendicular to the speed of the electron*'.

(b) Most candidates effortlessly gave a perfect answer for the force acting on the electron. A small, but disturbing number of candidates used a variant of the Coulomb law to find the value of the force.

(c) Most candidates managed to successfully calculate the magnetic flux density as 1.4 mT. A good number of candidates used $F = BQv$ to find the magnetic flux density B. A pleasing number of candidates derived the equation $B = \frac{mv}{Qr}$ and used this to calculate the magnetic flux density. A small number of candidates struggled to rearrange the equation $F = BQv$.

(d) This was a challenging question that discriminated well. A good number of candidates in the upper quartile correctly used Einstein's mass-energy equation and the photon energy equation to determine the wavelength of the gamma rays. Some candidates used the mass of the electron and positron but then forgot that two photons were emitted in the annihilation. Most candidates lost all three marks for using the kinetic energy equation or the de Broglie equation. About one in ten candidates omitted this question.

Question 3

(a) (i) Most candidates gave a correct answer of 100 Hz for the frequency of rotation of the coil. The most common incorrect answers were 0.01 Hz, 0.1 Hz and 67 Hz.

(a) (ii) Most candidates were familiar with the concepts of magnetic flux density and magnetic flux linkage and ended up securing three marks. A small number of candidates omitted the 10^{-2} factor for the magnetic flux linkage when using the equation 'flux linkage = NBA'. Some candidates inexplicably used 4×10^{-2} Wb-turns for the maximum flux linkage or the equation $F = BIL$. About a quarter of the candidates scored no marks.

(a) (iii) This question suited many of the candidates in the upper quartile. Many of them realised that the maximum e.m.f. was numerically equal to the maximum gradient of the graph. It was good to see correct tangents marked on Fig. 3.1 and correct substitution to determine the gradient. A small number of candidates either derived or were familiar with the equation for the peak e.m.f. for a rotating coil. It was admirable to see the correct answer for the e.m.f. of 4π volts. Most candidates were baffled with this question, but many scored a mark for quoting Faraday's law in words or in an equation form.

(b) Most of the candidates were able to correctly calculate the power dissipated in the resistor.

Question 4

(a) Most candidates scored either one or two marks for their explanations. Most candidates realised that there was a repulsive electrostatic force between the gold nucleus and the alpha particle. Some even appreciated the role played by momentum in this two-body interaction. A small number of candidates thought that the strong nuclear force was responsible for the behaviour of the alpha particle.

(b) About half of the candidates drew correct field lines from points A and B. The examiners also saw strange field patterns. A significant number of candidates showed both field lines going above the dotted line shown in Fig. 4.2 and a small minority showed field lines linking the charges, as if they were oppositely charged.

(c) This was a 'show' question. It was absolutely vital for candidates to show all their working, including the values substituted into the equation. Most candidates did manage to score maximum marks. However, a significant number of candidates made the following mistakes:

- not showing the substituted value for the permittivity of free space
- forgetting to square the separation term in the equation
- using 79 and 2 as the value for the charges, instead of 79*e* and 2*e*

(d) Most candidates drew a smooth curve. It was good to see some of the values calculated to help with the graph plotting. Some candidates drew a straight line from the origin to the cross marked on the grid before doing their curve. Generally, the quality of the curve was poor, with the graph touching or crossing the horizontal axis.

Question 5

(a) Most candidates correctly stated the number of neutrons in the uranium isotope to be 142. Some of the incorrect answers were 144, 92 and 238.

(b) (i) Most candidates did well in this 'show' question. Most candidates were familiar with the mega prefix and the conversion factor for electron-volts to joules.

(b) (ii) The vast majority of the candidates correctly used the equation for kinetic energy to calculate the speed of the alpha particle. Some candidates ignored the mass of the particle given in this question and attempted to calculate it using the mass of the neutron and proton or unified atomic mass u. A small number of candidates used the mass of an electron instead of the alpha particle.

(c) (i) Most candidates did manage to score a mark, but only after trying several attempts at using the numbers available in the question. Some candidates attempting to use the equation $A = \lambda N$ or $A = A_0 e^{-\lambda t}$ and then found that they could not proceed any further. This question demonstrated that many candidates did not fundamentally understand the meaning of the term activity.

(c) (ii) Most candidates correctly determined the decay constant from the half life of 88 years. Inevitably, some candidates failed to convert the half life into seconds. A significant number of the candidates in the lower quartile either determined the decay constant for a period of 1 year or simply omitted the question altogether.

(c) (iii) This question discriminated well and favoured candidates who had decent synoptic knowledge of moles. About a third of the candidates secured full marks. A disappointing number of candidates attempted to use the Avogadro constant to determine the number of plutonium-238 nuclei. There was a wide range of values for the mass of plutonium; the smallest was about 10^{-26} kg and the largest about10^{26} kg.

Question 6

(a) Most candidates successfully communicated their physics when describing how neutrons led to a chain reaction. The most common misconceptions were that the neutrons reacted with the daughter nuclei or with uranium atoms (as opposed to uranium nuclei).

(b) Most candidates scored three or more marks for this question. Generally, the role of the fuel rods was appreciated by most candidates. A small number of candidates thought that the fuel rods were '*a source* of *neutrons'*. Most candidates mentioned that the controls rods were made of boron and they '*absorbed the neutrons'*. Almost all candidates understood that the role of the moderators was to '*slow down the fast moving neutrons*'. Many elaborated on inelastic collision between the fast-neutrons and moderator atoms and how the moderator should not have the ability to absorb the neutrons. A significant number of candidates appreciated that thermal or slow moving neutrons have '*a better chance of causing fission reactions with uranium-235 nuclei*'. Many candidates spent a disproportionate amount of time on the effect of lowering and raising the control rods from the reactor core. Only a very small number of candidates realised that on average, a single thermal neutron between successive reactions was necessary to sustain controlled chain reactions in a reactor.

(c) (i) The majority of the candidates were able to calculate the total power output of the reactor. A very small number of candidates multiplied the actual power by either 22% or by 0.22.

(c) (ii) The error carried forward rule made sure that most candidates gained a mark for multiplying their value for the power output by the time of 1 day in seconds.

(c) (iii) Almost an equal number of candidates scored either two marks or zero. A disappointing number of candidates attempted to use Einstein's mass-energy equation to determine the mass of uranium. Some candidates randomly multiplied and divided the data given in this question.

(d) Most candidates gave clear answers and showed a good awareness of the environmental issues related to nuclear waste. Many candidates focused on the long half lives of the waste products and the potential damage caused by the ionisation.

Question 7

(a) Most candidates managed to state at least one of the properties of X-rays. The most popular correct answer was '*they are electromagnetic waves and travel at the speed of light*'. Some candidates focused on what X-rays could do, for example, '*they produce photoelectric effect*' and '*they are absorbed by bones*'.

(b) Many candidates in the upper quartile gave perfect answers in terms of an X-ray photon colliding inelastically with an orbital electron with the removal of the electron and the scattering of a longer wavelength photon. About half of the candidates scored nothing in spite of writing a great deal. The statements often lacked rigour and precision. On some occasions, the descriptions were an amalgamation of Compton effect and pair production. A disappointing number of candidates, about one in ten, omitted this question.

(c) (i) Almost all candidates correctly identified I_0 as the initial intensity of the X-ray beam.

(c) (ii) It was a pleasure to see flawless answers to this sophisticated question. Almost three quarters of the candidates gained three marks. Those candidates who stumbled did so because they either used logs to the base 10 or converted the cm^{-1} incorrectly into m^{-1}.

(d) Most candidates understood the idea of using contrast material to reveal soft tissues on X-rays images and were also familiar with the high-Z requirement of the material. However, there were some bizarre statements such as '*contrast material emit gamma rays*' and '*contrast material increase the acoustic impedance of tissues*'.

Question 8

(a) The answers to this MRI question were very much Centre-dependent. Some candidates in the upper quartile showed exquisite knowledge of this complex diagnostic technique. Difficult concepts such as quantum-nuclear spin and precession were communicated accurately. Most candidates, however, showed superficial knowledge of magnetic resonance imaging; such candidates quoted technical terms but showed little or no understanding of them. A significant number of candidates did not appreciate the role played by the radio waves from the transmitting coils or the process by which the MRI system identified relevant tissues. A disappointing number of candidates thought that the gradient coils detected radio waves emitted by the relaxing nuclei. Relaxation time of the nuclei was mentioned by many candidates but it was the least understood term. A small number of candidates thought that atoms were resonating and emitting radio waves. It was clear that many candidates remain mystified by the principles of magnetic resonance.

(b) This was generally well answered with most candidates scoring at least a mark for mentioning a major difference between an MRI scan and a PET scan. The idea that PET scans reveal metabolic functions was outlined by some candidates. A few even mentioned how radiopharmaceuticals containing F-18 were being used in PET scans to identify early signs of Alzheimer.

Question 9

(a) Most candidates coped adequately with the explanation of fusion and gave robust explanation of the conditions necessary for stellar fusion. A small number of candidates thought that fusion was the amalgamation of '*atoms'* or '*elements'*. A significant number of candidates gave excellent exposition of electrostatic repulsion between nuclei and the important role played by the strong nuclear force.

(b) Most candidates gave enthusiastic description of the fate of a star with mass much greater than our Sun. Most candidates scored three marks for correctly identifying the three stages as red giant, supernova and neutron star or black hole. A small number of candidates made reference to mysterious objects such as '*red dwarf'*, '*black dwarf'* and '*red giant supernova'*. A disturbing number of candidates also thought that a white dwarf first evolved into neutron star and then ultimately into a black hole. A very small number of candidates described stellar formation rather than stellar death.

Question 10

(a) Most candidates effortlessly used the equation for Newton's law of gravitation to determine the force between two galaxies. Some of the most common errors were:

- forgetting to square the distance term in the equation
- doubling the mass instead of squaring the masses of the galaxies
- using the incorrect mass of 10^{30} kg for the mass of the galaxy
- using 9.81 for the value of G

(b) A good number of high-scoring candidates realised that the galaxies were moving apart from each other. A small, but significant number of candidates were aware of dark energy and its impact on the motion of the galaxies. Many candidates resorted to guessing and alleged that the galaxies were pushed away by '*radiation pressure*' or *'Fermi pressure*'. A few went further by suggesting that the '*strong nuclear force was responsible for repelling the galaxies'*.

(c) This was a well answered question. About a quarter of the candidates scored maximum marks. The descriptions were often clear and the different stages were sequenced correctly. Most candidates started off with a singularity and ended up with the universe sprinkled with galaxies and saturated with the microwave background radiation.

(d) (i) Many candidates focussed on red-shifting of the spectrum from the distant galaxies. Only a small number of candidates mentioned the appearance of dark lines or bands on a continuous spectrum.

(d) (ii) This was a tough and quite discriminating question. Many candidates in the upper quartile successfully used the Doppler equation and the Hubble law equation to calculate the distance of the galaxy in Mpc.

G486 Practical Skills in Physics 2

General Comments

The third moderation session of the A2 Practical Skills in Physics 2 went smoothly with many Centres taking on board the comments made last year. Again there were fewer clerical errors this year with the majority of centres now using the front cover sheets. It was noted that where clerical errors were made, it was usual to find that the Centres concerned had not used the candidate cover sheets.

The annotation of written prose in the evaluative tasks indicating which of the marking scheme points were being credited was once again found in most cases to be very helpful by moderators in determining how the candidates' work had been interpreted.

A small number of Centres still failed to include the MS1 and CCS160 forms. Some Centres included nine pieces of work for each candidate, leaving the moderator to choose which pieces to moderate. Only the pieces of work that contribute towards the candidate's final mark should be included. It was found to be very helpful when Centres used treasury tags to keep a candidate's work together rather than A4 plastic envelopes.

There was an increased tendency for a number of Centres to mark in pencil. A number of teachers have used green pens to mark work. It would be helpful if all work were marked in red, with internal moderation taking place in green.

For consistency across Centres it is also essential that the mark scheme be adhered to as strictly as possible. Where a teacher has doubt, the use of the free consultancy service is strongly recommended. Many Centres made contact with OCR over the past year and were able to clarify their queries.

Qualitative Tasks

General Comments

The qualitative tasks were generally well marked. Where candidates are asked to perform a valid numerical test to confirm a relationship, they should explain their workings if they are to gain credit.

In Task 1, it was not uncommon for candidates to state the period *T* without showing the measured 10*t* value. Some Centres allowed full credit for this even though the mark scheme detailed the requirement that 10*t* is shown.

When the valid numerical test is made, candidates had to show whether it supported the suggestion. Many candidates achieved a value and merely stated that it lay within 10% of the value without showing any calculation. Similarly, some candidates calculated the percentage difference and then failed to go on to make a conclusion.

In B1.2 it is necessary for candidates to make reference to the magnetic properties of iron / steel in the clamp stands. Many candidates were given credit for saying that ' a metal stand attracts the magnet'. (A statement such as this should not have been given credit.)

Candidates seemed to get their heads around Task 2 and in spite of the complicated introductory steps, successfully completed the task. A number of candidates still failed to include in their table of results, the readings taken for the first set of results even though the instructions emphasised the need for the inclusion of all data. Candidates should be encouraged to record all measurements taken in any table of results.

The question on safety was frequently answered by rewording the instructions concerning the use of the string. A number of candidates also described the use of oven gloves to carry a small beaker of boiling water across the lab and should not have been given credit for this. When marking this, credit should be given for the extra care **that was taken** (specifically in pouring boiling water into the beaker or lowering the mass into the beaker of boiling water, as described in the mark scheme.)

Task 3 was the new task this year. There were some problems with the fall time for two magnets, with some candidates finding that the magnets were getting stuck in the copper pipe. Candidates were not penalised for this and where centres communicated their issues, they were told to use the number of magnets in the range 3 to 8. While this produced a differently shaped curve, it still allowed candidates the full range of marks in B1.2. It was noticeable that candidates were writing off the first single magnet timing as anomalous, even though it had been repeated a number of times.

Quantitative Tasks

It is expected that most candidates should be able to follow instructions, record measurements taken in an appropriate table of results and plot a suitable graph. It is essential that candidates are reminded that **all raw data measured must be recorded in their table of results**. It was less common this year to find the omission of raw *t* in the table of results.

There still remains some confusion as to the difference between the number of decimal places quoted in a measurement of raw data and the number of significant figures quoted in processed data.

It was not uncommon to find the mark for the line of best fit mark in C1.2 to be awarded generously. While most teachers are following the mark scheme guidance and ringing two suspect plots, there are still centres who fail to put any annotation on the graph and just fill in the mark boxes. It is expected that teachers check two of the plotted points that lie furthest from the candidate's line of best fit. These should be circled and if correct, ticked. Moderators have been instructed to confirm the position of the two plots circled only. However, in the event that ticks are placed by two plots near the line, moderators will check the two plots furthest from the line. This may lead to a difference in the teacher's mark and increase the chance of putting the centre out of tolerance.

The use of more than half of the graph paper was marked well. A few Centres were still penalising candidates whose points fulfilled the 4 x 6 large square grid criteria, but which did not look like it covered more than half of the graph. (See the Practical Skills Handbook.) It is important to have a supply of OCR graph grids at the start of all Quantitative assessments, so that if candidates require a second sheet of graph paper, they do not gain a possible advantage in the larger grid.

Many more candidates showed their workings in the calculation of the gradient. There were once again, fewer small triangles used to determine the gradient. The C1.3 mark should not be awarded if the points used came from the table of results rather than from the line of best fit (unless those two points chosen were common to both).

The justification for the number of significant figures quoted in the final answer C2.3, still proves a stumbling block, both for candidates and some teachers who are still crediting responses that say 'I quoted my answer to 2 significant figures because that was the least number of significant figures in my data.' Candidates must make reference individually in their response to each measurement taken.

Evaluative Tasks

The Evaluative Tasks continue to be challenging for weaker candidates. There are a large number of higher demand marks in these tasks and Centres should not give credit for weak or vague answers.

The pattern of candidate response is unchanged from last year with the calculation of 'uncertainty' in measurements and the percentage difference calculation generally being well done.

Where candidates are asked to draw a worst acceptable line, they should be reminded that there is a fair distribution of plots either side of this line. A number of candidates were given full credit where lines that bore little correlation to the plots were drawn.

In C3.2, there continues to be confusion between the terms *accuracy* and *reliability*. A number of centres were generous in awarding marks for a single sentence with ambiguous phrasing. It is suggested that candidates be encouraged to approach each term independently, allotting a separate sentence for each.

Where a comment about the reliability of the experiment is required using both the graph and the table, the additional guidance should be followed. Extra detail is required when comparing the difference in repeat readings shown in the table. It is not sufficient to say that 'the readings are close and so the experiment is reliable'.

In C4.1 most candidates were able to gain credit for stating two limitations. Vague statements were again given credit by some Centres and where the mark scheme was not followed, it was not unusual for those candidates to lose 2 or 3 marks, almost certainly bringing the Centre out of tolerance. The C4.2 improvement must be linked to an identified limitation.

A number of Centres gave full credit in C4.1 where candidates identified *human error* as a limitation. The mark scheme clearly makes reference to *human error* being linked to a process, i.e. starting / stopping the stopwatch. This detail is required to avoid the mark from becoming trivial. It is essential that the additional guidance be followed.

The last part of each Evaluative Task (C4.3) requires candidates to identify one source of uncertainty and indicate the likely effect that this uncertainty would have on the quantity determined. Candidates should use a step-by-step approach and include where appropriate, the effect on the gradient and/or *y*-intercept. It was again pleasing to see good candidates gain this mark.

The Future

The Tasks for 2012/13 were published in June 2012. One Qualitative, one Quantitative and its associated Evaluative Task have been replaced. The tasks that have been replaced may well be used again in future years and so **must remain confidential**. Where tasks are to be used again, it is essential that Centres use the current versions (identified at the bottom of each page by *'For assessment use between 1 June 2012 and 14 May 2013')* as in some cases, subtle changes have been made to reduce ambiguity. (Consequently mark schemes may also have been adjusted). These changes have been made to assist candidates in their answers.

Centres are always welcome to email OCR for clarification. There is also a coursework consultancy service available. Centres should submit coursework consultancies as they mark the tasks. Last year a number of consultancies were requested very close to the 15th May deadline and left little time for Centres to implement necessary changes following feedback.

Finally, all of last year's tasks, instructions and mark schemes continue to remain confidential.

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