

Physics A

Advanced GCE H558

Advanced Subsidiary GCE H158

Examiners' Reports

June 2011

HX58/R/11

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

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

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Chief Examiner's Report

Congratulations to Centres for preparing their students for the challenges of the Physics A specification. Centres have once again made good use of previous examination papers and mark schemes. A large number of candidates have improved their final aggregated scores by re-sitting the AS unit papers, notably G481.

The quality of analytical work showed some improvement. Numerical answers showed better organisation and candidates made fewer errors manipulating simple equations. Candidates continue to take advantage of the error carried forward rule when tackling analytical questions. A significant number of candidates could have improved their overall performance by carefully scrutinising questions before putting pen to paper. In extended writing questions, candidates are reminded that they can use bullet points to communicate their physics. All candidates, across the ability spectrum, need to learn their definitions. A definition can either be textual or in the form of an equation with all terms clearly defined. Examiners will, in the future, be looking for clearly expressed definitions before awarding marks.

All examination scripts are electronically scanned before being marked by examiners. Most candidates wrote their answers within the scanned zones for each question. It is inevitable that sometimes answers have to be crossed out. Examiners were grateful to the many candidates who clearly indicated where the alternative answers were being provided. In all the unit papers, Examiners commented on the poor handwriting of a very small number of candidates.

There was an error in the G485 paper; this was very unfortunate and we apologise for this. The marking scheme was adjusted to take account of this error in Question 3(c). The evidence from Examiners was that this error did not unsettle the vast majority of candidates. A statistical comparison with a similar question in the June 2010 paper showed that candidates had done marginally better this year. This error was given full consideration when decisions were made on the grade thresholds for the G485 paper.

Most Centres did well to prepare their students for the assessment of the practical skills. The application of the marking schemes was much more consistent and there were fewer clerical errors made by Centres. A significant number of Centres failed to submit sample results for the qualitative and quantitative tasks to the Moderators. This made it much harder for the Moderators to make their judgements.

As always, experienced teams of Examiners 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. These statistics are the basis of OCR's Active Results, which is available to Centres (http://www.ocr.org.uk/interchange/active_results/index.html) and enables further analysis of the performance of their candidates in the examinations.

The report for each unit of the June 2011 examination is given below.

G481 Mechanics

General Comments

The marks for this paper ranged from 0 to 60 and the mean score was around 36. This profile was almost identical to the performance of candidates in June 2010. Almost all candidates finished the paper in the allotted time.

Centres have once again made effective use of past papers and mark schemes. The standard of work from the candidates was slightly better. The majority of candidates worked hard to present their analytical answers in a logical order. Some candidates struggled with simple mathematical operations and resorted to mnemonic triangles when rearranging equations. The standard of descriptive responses lacked reasoning and structure. Most candidates would have benefited from writing their answers as bullet points. The handwriting of an increasingly small number of candidates is giving Examiners serious cause for concern.

In this paper, two marks were reserved in Q5(a) and Q7(a) for correctly using and spelling two technical words; almost all candidates secured both marks.

Comments on Specific Questions

- 1 Most candidates made a good start with this opening question and scored three or more marks.
- 1 (a) (i) A significant number of candidates gave '*force constant*' as their answer for the area under the force against extension graph. Other popular incorrect responses were stress, strain and Young modulus. Candidates in the upper quartile had no problems writing down either '*work*' or '*elastic potential energy*'.
- 1 (a) (ii) This was well answered with almost all candidates being aware of the significance of the area under a velocity against time graph. About one in ten candidates thought the area represented acceleration.
- 1 (b) Candidates were brief with their answers with most securing two marks. The most popular answers were '*moment*' and '*work done*'. A very small number of candidates wrote down '*joules*' and consequently scored no marks.
- 2 Most candidates scored over three marks and generally did well interpreting the information given in Fig. 2.1.
- 2 (a) The majority of candidates stated a correct definition for *density*. A good number of candidates quoted the equation and defined all the terms; this was acceptable. About one in five candidates gave vague descriptions such as '*density is the amount of matter in space*'.
- 2 (b) (i) The answers from most candidates lacked precision. Many candidates mentioned that there were three distinct layers but gave no reasoning or explanation. Only good candidates gave lucid answers in terms of dramatic changes in the density at depths of 3.0 Mm and 5.1 Mm.
- 2 (b) (ii) About a third of the candidates scored three marks and provided elegant solutions. In the calculation, most candidates were able to determine the mass of the central core but the identification and calculation for the volume of the

core caused difficulty for a large number of candidates. Despite the formula for volume being given, some candidates used r or r^2 rather than r^3 . A significant number of candidates used the **depth** of the core as its **radius**. A disappointing number of candidates totally ignored the information given and determined the mean density of the Earth. Very few candidates ignored the 10^6 factor for the depth.

- 3 Most candidates scored over eight marks and demonstrated a good understanding of vectors and triangle of forces.
- 3 (a) These were easy marks for most of the candidates. The definition for a vector was succinct and candidates gave decent examples of vectors.
- 3 (b) (i) Most candidates correctly determined the magnitude of the force to be 8.1 N. But, a disappointing number of candidates scored nothing for ' $7.0 \times \cos 30^\circ = 6.1$ N'. A small number of candidates had their calculators in radian mode.
- 3 (b) (ii) About a third of the candidates scored full marks. A significant number of candidates failed to realise that the work done by the force was simply ' $7.0 \times 5.0 = 35$ J'; unfortunately they used their answer to (b)(i) instead of 7.0 N to calculate the work done. Invariably almost all candidates correctly determined the rate of work done using their value from (b)(i)1.
- 3 (c) (i) Most candidates realised that the magnitude of the resultant of the tensions in the cables was equal to the weight. A significant number of candidates misread the question and thought the resultant force was zero. In spite of this error, such candidates still managed to give the correct direction of the resultant force.
- 3 (c) (ii) Most candidates correctly determined the magnitude of the tension T . The drawings for the vector triangle of forces were generally poor. Correct labelling and direction of arrows were mostly seen on scripts of the more able candidates. About a third of the candidates scored nothing because of inappropriate diagrams and **incorrect** calculations such as
- $$T = \sqrt{70^2 + 120^2} = 134 \text{ N}.$$
- 4 Most candidates scored six or more marks. The presentation of numerical answers was often quite good.
- 4 (a) There were some perplexing responses such as '*air resistance*', but generally, candidates gave at least one correct factor affecting drag. Vague answers such as '*shape*' or '*size*' were not allowed. About one in five candidates gave completely inappropriate answers such as acceleration, weight and mass.
- 4 (b) (i) Almost all candidates correctly drew two labelled arrows for drag and weight on Fig. 4.1.
- 4 (b) (ii) Only a small number of candidates incorrectly calculated the weight by dividing the mass by the factor 9.81. The majority of candidates correctly calculated the weight to be 740 N and appreciated its importance in the next question.
- 4 (b) (iii) This question discriminated well and credited candidates with marks for spotting that the net force on the skydiver was the difference between the weight and the value of the drag at 20 m s^{-1} . Some candidates calculated the drag and ignored it completely when determining the instantaneous

acceleration. One mark was awarded to candidates who correctly determined the drag and divided it by the mass to get 1.6 m s^{-2} . The final missing step was to subtract this value from 9.81 m s^{-2} .

- 4 (c) (iv) Most candidates took the hint from the command term 'State' and gave brief answers; often the one word answer 'equal'. The majority of candidates used the answer here as a helpful prompt for the answer to (c)(v).
- 4 (c) (v) This was well answered by most candidates with clearly laid out answers. The rearranging of the equation was competently tackled by even candidates of all abilities. About one in six candidates omitted this question.
- 5 This first part of this question provided opportunities for candidates to demonstrate their experimental skills and knowledge of equations of motion. The second part once again showed candidates' superficial understanding of GPS.
- 5 (a) Most candidates scored over four marks. The majority of candidates correctly identified height and time as the two key measurements and identified the appropriate instruments as the metre rule and a stopwatch. Most candidates then went on to quote the equation $s = ut + \frac{1}{2}at^2$ but then failed to develop this equation. Most candidates were able to identify air resistance as a reason for the value of g being an estimate. A disappointing number of candidates made reference to light-gates or lasers that automatically registered the time or the velocity of the falling ball. Some candidates used $v = \frac{d}{t}$ to find the final velocity of the ball before substituting the value into $a = \frac{v}{t}$. A significant number of candidates also decided to determine the mass of the ball using a digital balance, but this had little bearing on their analysis.
- 5 (b) (i) Most of the candidates gave radio waves or microwaves as the answer. About one in ten candidates thought that satellites transmitted coded signals using visible light or infra red radiation.
- 5 (b) (ii) This was not well answered and the modal mark for this question was zero. A disturbing number of candidates thought that the signals transmitted by the satellites were **reflected** off every car on the Earth's surface. The time taken for this reflected signal was used by the satellites to determine the location of the GPS receiver. To many candidates, it was the 'satellites that calculated the distance of the car'. This question demonstrated candidates' poor comprehension of the part played by the satellites and the GPS receiver in the car.
- 5 (b) (iii) Although most candidates managed to secure one or two marks, their understanding of trilateration was poor. The unlabelled diagrams of overlapping circles, satellites, car and Earth's surface did not support the textual information provided by the candidates.
- 6 This was a high-scoring question with most candidates demonstrating a good understanding of energy and its transformation.
- 6 (a) A variety of answers were accepted by the Examiners. Most candidates correctly recalled the principle of conservation of energy. A small number of candidates lost marks for vague answers such as 'energy is always conserved' or 'it is important to conserve energy before it all runs out'.

- 6 (b) (i) Most candidates correctly calculated the loss of gravitational potential energy of the falling mass. Unfortunately, about one in five candidates either used 2.8 m s^{-2} instead of 9.81 m s^{-2} or used 0.25 kg instead of 0.10 kg .
- 6 (b) (ii) Congratulations to the majority of the candidates who effortlessly used $v^2 = u^2 + 2as$ to show that the velocity of the glider was 1.8 m s^{-1} . Some candidates, however, need to be reminded to show all their steps in a 'show' question and to quote the final answer to a greater number of significant figures.
- 6 (b) (iii) Almost all candidates scored two marks for substituting the value given in (b)(ii) into the equation for kinetic energy. A few candidates used 0.10 kg when calculating the kinetic energy of the glider.
- 6 (b) (iv) This proved to be a tough question for most candidates, even those who eventually went on to secure a grade A. Candidates were keen to blame air resistance or friction at the pulley for the answers (b)(iii) and (b)(i) being different. Only a very small number of candidates realised that kinetic energy of the falling 0.10 kg mass had a part to play.
- 7 Most candidates scored over five marks and demonstrated a good knowledge of stress against strain graphs.
- 7 (a) (i) Hooke's law was quoted well by most candidates. A disturbing number of candidates lost the mark because they could not spell 'extension' correctly. Examiners relaxed the mark scheme and allowed '*stress is proportional to strain*' to be equivalent to Hooke's law.
- 7 (a) (ii) The majority of candidates scored two or three marks. A significant number of candidates were baffled by the pico and nano prefixes. Some candidates simply could not cope with the powers of ten. A few candidates multiplied the force and extension but still managed to pick up marks for the correct conversions of force into newtons and distance into metres.
- 7 (b) (i) Most candidates knew that they had to use values from the **linear** section of the stress against strain graph in order to determine the Young modulus. However, a significant number of candidates lost marks either for incorrect powers of ten or not knowing the unit for Young modulus. The most popular incorrect unit was quoted as N m^{-1} . Weaker candidates lost the most marks by dividing the breaking stress (60 MPa) by 1.14×10^{-3} .
- 7 (b) (ii) Almost half of the candidates finished the paper by picking up two marks in this last question. The most common error was ignoring the powers of ten, although a significant number of candidates chose an incorrect breaking stress.

G482 Electrons, Waves and Photons

General Comments

The performance of candidates ranged from excellent; those who understood the physics behind the questions very well, to weak; those with little knowledge and lots of guesses.

More candidates appreciate the level and quality of answer expected of them than two years ago when this new specification was first examined.

It appeared that there were plenty of opportunities for good candidates to demonstrate their knowledge on the many topics covered. Also there were many accessible parts to most questions for weaker candidates to score marks.

Candidates could have scored more marks easily just by learning the definitions of quantities more precisely. For example only 15% scored full marks for the definition of *potential difference*. Only 20% could describe clearly the difference between *displacement* and *amplitude of a wave*.

There was sufficient time to complete the paper and weaker candidates managed to attempt to answer most sections in every question. Candidates scored freely in the first question proving it to be a good introduction easing them into the paper. This continued through questions 2 and 3, also on electric circuits. Several sections within these three questions successfully differentiated between the different abilities. Question 4 on quantum physics proved to be more exacting but also differentiated well. The descriptions in question 5 showed clearly those who could explain the difference between *progressive* and *stationary waves* using technical terms correctly. Question 6 about *wave interference* proved to be a good discriminator where many were able to show their knowledge and understanding and score highly. Question 7 required candidates to apply their knowledge of *polarisation* to a simple experimental situation. Most made a full and spirited attempt but not always an accurate one, showing that they still had energy after such a long paper.

Most of the mathematical sections were well laid out. However many descriptive responses still lacked structure and careful argument. Also some of the handwriting was difficult to decipher.

- 1 (a) Many candidates still believe that resistance is found using the gradient of the *I-V* characteristic rather than reading the values at the chosen point. However all appreciated that the curve meant that Ohm's law is not obeyed.
- 1 (b) The calculations were done well with few errors.
- 1 (c) Few candidates were able to give a full definition of potential difference. All used the correct formula to calculate the power drawn, but many tried to substitute impossible values like 12 V or 120 mA. There were many good circuit diagrams but also many with incomplete or inaccurate symbols, incorrect polarity of the LEDs with respect to the cell. A significant number drew a series rather than a parallel arrangement.
- 1 (d) There were many sensible suggestions with most gaining this final mark.
- 2 (a) Most were able to calculate the resistance of one strip. Those, who could not, rarely made much sense of the rest of this section. The section proved to be a good discriminator with many scoring full marks.

- 2 (b) Most were able to write down the correct formula. The two most common errors were to substitute the parallel value resistance rather than the single value and to include a factor of π in the area calculation.
- 2 (c) Good candidates used $P = V^2/R$ to explain clearly why the resistance is the same. Most divided by 8 to find the series resistance and realised that the parallel circuit would continue to function with a broken element.
- 2 (d) Answers were usually both correct or both incorrect.
- 3 (a) Most could explain the term but some were not sufficiently precise using, for example, *power over metre squared* instead of *power per unit area*.
- 3 (b) Many candidates missed the point of the question by comparing the value of the resistance in the day to that at night.
- 3 (c) Almost all could read the graph correctly but many forgot the kilo factor in part ii which caused them problems in part iii unless they solved the problem by using a ratio of voltages.
- 3 (d) This question was a good discriminator with the vast majority reading correctly from the graph but then only the better candidates appreciating the potential divider aspect of the question to achieve a correct solution.
- 3 (e) The majority recognised the problem but often failed to pursue it to its full conclusion of switching continuously.
- 4 (a) Most recognised the photoelectric effect. The few who did not chose *ionisation*. The word *minimum* was often omitted from the definition of work function. Most performed the two calculations requiring substitutions into formulae successfully. The last calculation distinguished well between those who understood the photoelectric effect and those who did not.
- 4 (b) This section discriminated well with the better candidates scoring full marks and the average candidate managing one part successfully.
- 4 (c) This proved to be the most difficult calculation on the paper and any candidate who recognised the problem correctly is likely to have gained a top grade.
- 5 (a) The majority gave the correct wavelength but the graph, being in an unfamiliar form led to a minority choosing half of the answer. The explanations as to why 0.75 needed to be doubled often mixed time and distance in an illogical way in a single sentence. The unit of milliseconds was also often forgotten in the calculation.
- 5 (b) This question proved to be a good discriminator with only the better candidates giving the correct answer.
- 5 (c) Most candidates could define amplitude but many struggled to find suitable words to define displacement. Stronger candidates contrasted energy transfer with stored energy to distinguish progressive and stationary waves. Weaker candidates just stated that one transferred energy and the other did not. There were many vague statements about waves moving rather than about shape or information transfer.
- 5 (d) Many scored full marks but there was a minority who generalised about stationary waves, not relating their answer to the specific situation of the question. In the last part most gave the difference in amplitude and the position of the antinode correctly.

However the incorrect positioning of point Y indicated that there was still a considerable lack of understanding about the oscillation.

- 6 (a) Only a minority recognised that coherence was the prime requisite for producing a pattern on a screen. Many just considered the paths to the screen and there were erroneous statements about the slits being narrower than the wavelength of the light. In the second section many gave perfect answers but a common fault was to mix or confuse phase and path difference.
- 6 (b) Almost all candidates scored some marks. The most common error was to divide the given distance by 6 instead of 5. Also some forgot that the slit separation was given in millimetres.
- 6 (c) The majority wrote good answers appreciating that the fringe interference pattern disappeared to be replaced by a broad band of light on the screen caused by diffraction at the slit.
- 7 (a) Most of the answers just repeated the question by stating that *the wave oscillates in one plane*. Many scored one mark by referring to a transverse wave. Very few referred to the vibrations being in one direction.
- 7 (b) Descriptions of the experiment did not focus on the essentials required. Often two polarising filters were suggested; candidates not appreciating that the reflecting surface acted as the first polariser. Most either rotated the filter or varied the angle of reflection to gain some marks.
- 7 (c) Many stated Malus' Law correctly but then some tried to incorporate the 53° of the previous part in explaining the angle of polarisation.

G483 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.

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.

Marking should be carried out in red pen – there were occasions this year where the difference between the writing of the marker and the writing of the candidate could not be distinguished.

It was clear that the majority of larger centres had carried out appropriate internal moderation. Moderators did occasionally experience difficulties where a piece of work had been marked several times in a centre as part of an internal moderation process; 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 should be 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 on Interchange 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

Moderators found that the introduction of the cover sheet helped the moderation process this year. There were still arithmetic/transcriptions errors with marks in just less than one tenth of centres. It is good practice for centres to ensure that there is a suitable procedure for checking the compilation of marks. A large number of centres successfully used the spreadsheet which is available on "OCR Interchange" to assist the process. Centres are advised to use both the spreadsheet and the cover sheet. The Cover sheet also allows for additional information to be given to the moderator, for example indicating that a task was previously submitted.

Centres are required to submit one type of each task for each candidate. There was still a significant minority of centres who submitted all the tasks completed for each candidate. Where centres submitted more than one task of each type, moderators are required to return the sample to the centre; this delays the moderation process.

A number of centres did not always follow the rule on resubmitting tasks correctly. The procedures for centres who wish to re-enter candidates for this unit may be found in the 'Frequently Asked Questions' section on 'OCR Interchange'.

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.

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 may 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.

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. 'Hairy' lines must 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. 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. Candidates should be reminded that **all** the raw readings should be recorded. 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 span 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 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.

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 C4.1 and C4.2, the mark schemes allow for "one other detailed 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.

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. It was pleasing to see good candidates gain this mark.

In conclusion

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

Centres are always welcome to email OCR for clarification. 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

The majority of candidates appeared to have been well prepared for this examination and there were very few extremely weak scripts. The exam paper provided ample opportunity for candidates to demonstrate their knowledge and understanding of the specification content. There was no evidence of candidates being short of time to complete the paper.

Answers to questions involving calculations were generally much better than those requiring the definitions of laws, such as Newton's first law, and phenomena such as SHM and the kinetic theory of gases. There were a significant number of candidates that simply wrote down equations from the formula sheet but then made incorrect substitutions of values into them: making mistakes in the units used (e.g. using km instead of m) or simply not knowing what the symbols represented.

Comments on Individual Questions

- 1 (a) (i) Most candidates were able to score this mark. Some, however, incorrectly referred to constant speed.
- (ii) Many found it more difficult to score this mark because they offered rather awkward and often confused sentences. Some gave answers where the acceleration was replaced by a speed of 1 ms^{-1} and some where the acceleration had units of velocity. Some candidates confused the newton with the Joule and suggested that 1 kg moved 1 metre.
- (b) (i) Virtually every candidate obtained this mark.
- (ii) A few candidates incorrectly used $\text{velocity} = \text{distance}/\text{time}$ ignoring the fact that the aircraft was accelerating.
- (iii) Most candidates obtained this mark.
- (c) (i) Most stated that the force was towards the centre of the circle but some answers were too vague such as "perpendicular to the velocity".
- (ii) A large majority scored both marks but some carelessly used 55 instead of 120 and others forgot to square the velocity.
- (d) (i) Most scored the first mark for saying that it was at the top of the circle but other answers included 'at the bottom', 'on its way down', 'half way between the top and the bottom'. Very few candidates got the second mark. Often the explanation was very confused and demonstrated that the candidates really did not understand what was going on in circular motion.
- (ii) Again, many became confused and failed to realise that the centripetal acceleration that corresponded to weightlessness was 9.81 ms^{-2} (or g).
- 2 (a) (i) A surprising number of candidates could not do this. Some said the displacement was inversely proportional to acceleration. Perhaps they felt this explained the negative sign in the SHM equation for acceleration but very few presented the equation to explain what SHM meant.

- (a) (ii) About two-fifths of the candidates scored full marks. Some candidates left blanks and used ticks; had they followed the instructions to write 'true' or 'false' they might have scored more marks.
- (b) Again, the candidates struggled to score these marks. Many candidates did not write down the names of the measuring instruments they would use and some tried to convert the question to frequency rather than period. Although a few wrote about damping they used it to say that the period would change as the velocity would get less. They did not connect it with the angle changing. So the 'difficulty' for most candidates was that the time could not be measured accurately, thus completely missing the point of the question.
- 3 (a) About half the candidates correctly stated 'force per unit mass' but some tried to use $g = GM/r^2$ in their definition.
- (b) (i) Most recognised $g \propto 1/r^2$ but some left it as $g = GM/r^2$ making it much more difficult to score the marks. Most tried to use the numbers provided but many offered no explanation whatsoever and sometimes it was quite hard to follow exactly what they had done.
- (ii) The majority of candidates had the correct equation. A significant number lost the marks by not converting km to m. Some had written the radius in km and went on to 'apparently' calculate the right answer. To secure both marks the final answer needed to be expressed to at least 2 significant figures.
- (iii) The most common mistake here was to calculate the volume in km^3 and get the answer of 5.5×10^{12} for the density. Despite this high value they were still given 1 mark because they had only made one mistake.
- 4 (a) (i) Most scored this mark by referring to the 'latent heat of fusion'. Some wrote fussion (and a few stated 'fission') and a few did not mention 'latent heat'.
- (a) (ii) By far the most common spelling of vaporisation was 'vapourisation'; a common error.
- (b) (i) Most obtained the two marks but a common mistake was to convert the difference between the two temperatures into Kelvin: i.e. $82+273$.
- (b) (ii) About half of the candidates scored both marks. Common errors were 'energy lost as sound', and 'kettle not being 100% efficient'.
- (b) (iii) Most found this very difficult. Some wasted time by calculating the number of seconds in one year (this is shown on the data sheet) and very few students appeared to understand what they were doing. They also had difficulty in converting kWh to Joules.
- 5 (a) (i) Most could correctly state the meaning of an elastic collision but some forgot to specify that it was the kinetic energy that was conserved.
- (a) (ii) It was surprising that only about two-fifths of candidates scored two or more of the three available marks. Some repeated the information given in the question by stating that the collisions were elastic, others offered statements that were too vague: 'the volume of gas is negligible' or 'volume of the gas molecules is negligible', or 'time of collisions is negligible'.

- (b) (i) There were some good answers scoring both marks. Quite a high percentage of candidates gave 2.4×10^{-23} as their answer because they simply wrote the change in momentum as mv .
 - (b) (ii) The majority of candidates gave the answer of 2500 instead of the correct 1250 because they had failed to appreciate that the distance travelled between collisions was 0.4m (2×0.2 m).
 - (b) (iii) Quite a large proportion of candidates got a mark for the equation for force ($\Delta p/t$) but many were unable to convert that into the correct numbers. Many simply wrote down 4.8×10^{-23} N.
 - (b) (iv) Almost three-fifths of candidates obtained this mark but some suggested that the force would be the same at (b)(ii) because it was due to the collisions being elastic.
 - (c) (i) Most realised that this was a very straightforward question and gained the mark by carrying out the simple calculation required.
 - (c) (ii) In this question, two essential points were expected to be made: the idea of the random motion and that the gas was composed of a very large number of particles. Most mentioned one or other but very few stated both.
 - (c) (iii) Most got the idea of the KE or velocity increasing but many were unable to express clearly the reason that the pressure increased. Weak statements like 'there are more collisions' were not given credit.
- 6
- (a) (i) Most correctly drew a straight line through the origin and scored the mark. Some candidates simply guessed and drew a variety of curves.
 - (a) (ii) About two-fifths of candidates gave the correct answer of R or 8.31 as the value of the gradient; almost as many stated 1 or k .
 - (b) (i) About two-thirds scored full marks by correctly using $(V/T) = \text{constant}$, but some tried to use $Pv = nRT$.

A significant number failed to convert the temperatures into Kelvin.
 - (b) (ii) The majority of candidates got full marks. Some candidates tried using $pV = NkT$ and became confused about the difference between N and n .

G485 Fields, Particles and Frontiers of Physics

General Comments

The marks for this paper ranged from 0 to 93 and the mean score was around 50. The majority of candidates finished the paper in the allotted time.

There were fewer omissions this session and it is good to report that all candidates attempted to answer the questions. The standard of work was better, particularly with extended answers. Most of the mathematical solutions were well structured. However, not all candidates were aware of the importance of showing all the stages in their working for questions that included a 'show that' component. This was particularly true for the able candidates who combined several stages of a calculation in a single calculator operation or simply wrote an equation followed by the answer without any substitution.

The error on Q3(c) of the examination paper was very regrettable and we apologise for this. The evidence from the Examiners and the statistical analysis carried out by OCR showed that this error did not unsettle or concern the vast majority of the candidates. The overall performance for this question was slightly better than the comparable question 3(b) in the June 2010 paper. The priority in marking was to ensure that candidates would not be penalised by this error. The marking scheme was adjusted so that full credit could be given for the use of either 0.05 cm or 0.05 m for the separation between the plates. The vast majority of the candidates used 0.05 m from the diagram.

There were some very good scripts with clearly focused answers and well presented calculations. The comments that follow tend to relate mainly to the more disappointing aspects of candidates answers and opportunities that were missed.

- 1 (a) The majority of candidates were unable to correctly recall the definition for *electromotive force*. The weaker candidates thought it was something to do with the force exerted on the electrons. Many candidates gave vague descriptions without making it clear that e.m.f. is the energy transferred to electrical per unit charge. Candidates are reminded that definitions must not contain a mixture of quantity and unit; hence statements such as '*electrical energy per unit coulomb*' or '*joules per unit charge*' are simply wrong.
- 1 (b) This was generally well answered with candidates showing good understanding of the terms magnetic flux density and magnetic flux. Candidates are reminded that definitions can either be in words or as an equation with all the terms defined.
- 1 (c) (i) Answers from candidates lacked robustness and were very muddled. This was a low scoring question demonstrating a poor understanding of transformers. A small number of candidates thought that the soft iron core was responsible for carrying the varying current from the primary coil to the secondary coil. Too many candidates referred to '*changing field*' rather than '*changing magnetic flux*' and '*cutting flux*' rather than '*changing magnetic flux*'. Answers based on the concept of changing magnetic flux were in the minority and many of those lacked the clarity of expression necessary to score full marks.
- 1 (c) (ii) This was generally well answered with most candidates stating the need for more coils or turns on the secondary side of the transformer. No marks were awarded for changes made to the power supply connected to the primary coil.

- 1 (d) (i) Almost all candidates scored full marks for calculating the number of turns for the secondary coil. The answers were well structured with few candidates struggling with rearranging the turn-ratio equation.
- 1 (d) (ii) The modal mark for calculating the current and the power dissipated in the leads was one. The majority of candidates used either 12 V or 11.8 V rather than 0.2 V to calculate the current and the power. The successful candidates were those who carefully scrutinised the question and highlighted key data in the question. A small number of good candidates sketched helpful circuit diagrams to aid their calculations.
- 2 (a) With very few exceptions, candidates gave a correct definition for capacitance. Once again, candidates are reminded that definitions with mixed quantity and unit are unacceptable. Hence statements such as '*charge per unit volt*' or '*coulombs per unit voltage*' are incorrect.
- 2 (b) (i) Candidates gave a variety of incorrect answers; the most common answers were 1.5 V and 3.0 V. The majority of candidates thought the ratio of the p.d.s was the same as the ratio of the capacitances. About one in five candidates gave elegant solutions resulting in the correct answer of 4.5 V for the p.d. across the 150 μ F capacitor.
- 2 (b) (ii) Almost all candidates correctly used $Q = VC$ and their answer from (b)(i) to determine the charge stored by the 150 μ F capacitor.
- 2 (b) (iii) The vast majority of candidates correctly used $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$ to determine the total capacitance of the circuit. The answers were generally well presented and easy to follow.
- 2 (c) (i) This was well answered with candidates showing good understanding of prefixes. Candidates are reminded to show all their working in 'show that' questions and it is also helpful to quote their final answer to a greater number of significant figures.
- 2 (c) (ii) It is good to report that most candidates scored either two or three marks. The majority of candidates were able to sketch a correctly shaped curve starting at 6.0 V but fewer candidates gave a correct value for the p.d. at 5.0 s. A significant number of candidates thought that the p.d. across the capacitor was halved after a time equal to the time constant of 5.0 s.
- 2 (c) (iii) About half of the candidates scored full marks for the ratio of energies stored by the capacitors. Quite often, the marks were acquired through the error carried forward rule. Most of these candidates used $\frac{1}{2}V^2C$. A disturbing number of candidates used a p.d. of 6.0 V for both capacitors and consequently scored no marks.
- 2 (c) (iv) About a quarter of the candidates correctly stated that the ratio in (iii) remains constant but this was quite often a lucky guess. The modal mark for this tough question was zero. Most candidates wrote copiously about exponential decay of charge or potential difference without ever mentioning that the charge stored by each capacitor was the same.

- 3 (a) The majority of candidates correctly defined *electric field strength* as the 'force per unit positive charge'. Candidates who quoted the correct formula for the electric field strength usually went on to correctly define all the terms. A small minority of candidates incorrectly defined electric field strength as 'potential difference divided by separation'.
- 3 (b) This was a well answered question with most candidates drawing correct electric field lines between the charged plates and also getting the correct direction of the electric field.
- 3 (c) (i) The vast majority of the candidates correctly showed the direction of the acceleration at point **P**.
- 3 (c) (ii) As mentioned earlier, the error in this question did not perturb the vast majority of the candidates who invariably used the separation of 0.05 m given in Fig. 3.2. The answers were generally well presented with candidates determining the magnitude of the electric field strength, then the magnitude of the force and finally, the acceleration using $F = ma$. A significant number of candidates correctly substituted numbers into the equation $a = \frac{Ve}{md}$. Weaker candidates unsuccessfully attempted to use the equations of motion. A very small number of candidates thought that the path of the electrons between the parallel plates was circular and hence scored nothing for the incorrect analysis below
- $$a = \frac{v^2}{r} = \frac{(4.0 \times 10^7)^2}{0.05} = 3.2 \times 10^{16} \approx 10^{16} \text{ m s}^{-2}.$$
- 3 (c) (iii) This was generally well answered, but some candidates used a distance of 0.08 m to calculate a time of 2.0×10^{-9} s.
- 3 (c) (iv) About half of the candidates gained the mark for this question.
- 3 (c) (v) This was generally well answered with the more able candidates securing full marks.
- 3 (c) (vi) Almost all candidates quoted the correct equation for kinetic energy. The substitution for the speed was a bit erratic with weaker candidates using the initial speed of the electrons ($4.0 \times 10^7 \text{ m s}^{-1}$) rather than the final speed from (v).
- 3 (c) (vii) Inevitably, there were a wide variety of answers. It was good to see that more than half of the candidates drew sketches worthy of two or more marks. The most common errors were
- curve starting at zero value for E_k
 - straight line between 0 and 0.08 m
 - changing value for E_k beyond 0.08 m.
- 4 (a) The answers to this question were very much Centre-dependent. Almost all candidates knew the correct value for the prefix nano. The answers were well structured with only a small minority of candidates securing full marks. The most common mistakes included calculating the electrical force on one of the charges instead of the electric field strength, using the separation 3.5×10^{-2} m instead of 1.75×10^{-2} m and subtracting the individual electric field strengths at the midpoint between the charged spheres.

- 4 (b) There were some superbly structured answers in terms of Coulomb's law. A disappointing number of candidates attempted to use $F = EQ$ and the value of the electric field strength at the midpoint between the charged spheres from (a).
- 4 (c) This was a discriminating question with the more able candidates rising to the challenge. It is good to report that most of the answers were well structured and the physics was easy to decipher. Most candidates made a good start by drawing a vector triangle. Candidates who determined the complementary angle or used mass instead of weight to calculate the angle scored two marks and one mark respectively. About a third of the candidates scored no marks; half of them omitted the question.
- 5 (a) The answers given to this question were evenly split between force 'acting upwards' and 'acting downwards'; the correct direction was 'downwards'.
- 5 (b) The vast majority of candidates mentioned Fleming's left-hand rule. Inevitably, a few candidates mentioned the right-hand rule.
- 5 (c) (i) Almost all candidates used $F = BIL$ to get the correct answer of 0.016 N.
- 5 (c) (ii) The majority of candidates struggled to provide clear answers. Newton's third law was misunderstood. The answer of 2.516 N was a commonly stated incorrect value. The reasoning for this was frequently in terms of a **downward** force on the rod causing a **downward** force on the digital balance. The modal mark for this question was zero.
- 5 (d) Candidates struggled with this synoptic question. Many candidates failed to arrive at the conclusion that the resistance of the rod was inversely proportional to its cross-sectional area. Some candidates incorrectly reasoned that halving the diameter of the rod would halve its cross-sectional area, leading to a force of 0.008 N. A disappointing number of candidates thought that changing the diameter of the rod somehow altered the magnetic flux density between the magnets.
- 6 (a) This was a well answered and reasoned question with most candidates scoring more than three marks. Rutherford's alpha-scattering experiment was familiar to most candidates. The QWC mark was gained by almost all candidates. The majority of candidates were able to state that most of the alpha particles went straight through the foil and that the gold atoms were mostly empty space. Many candidates also correctly identified the charge on the nucleus to be positive. Sadly, some candidates wasted their time by discussing in great detail the experimental set up for this classic experiment.
- 6 (b) The answers here were generally well structured. Most candidates correctly identified the three fundamental forces acting on the nucleons. The range of the forces was sometimes ignored and there were many references to gravitational force being weak or insignificant. In their zeal some candidates simply forgot to mention that gravitational force was attractive. Weaker candidates either missed out the strong nuclear force or simply mentioned '*nuclear force*' which was not worthy of any marks.
- 6 (c) (i) This was a well answered question with most candidates correctly calculating the total mass and volume of the nucleus. A significant number of candidates failed to include the 235 factor in their calculation. A very small number of candidates calculated the surface area of the nucleus instead of its volume.

- 6 (c) (ii) Many candidates struggled to pick up a mark for this question. Many candidates stated that the '*nucleus was a perfect sphere*' or the masses of the '*nucleons was assumed to be the same*'. Very few candidates realised that there were gaps between the nucleons inside the nucleus.
- 7 (a) There were very few correct definitions for *critical density*. Most candidates simply stated that this was the density that governed the ultimate fate of the universe. A small number of candidates quoted the equation for critical density and defined all the terms; there were no marks for this response.
- 7 (b) Most candidates ought to be congratulated for providing clear and robust answers for the value for Hubble constant. A small number of candidates multiplied 65 km s^{-1} by 1 Mpc to get a value of $2.0 \times 10^{27} \text{ s}^{-1}$ for the Hubble constant, which was significantly far away from the correct value of $2.1 \times 10^{-18} \text{ s}^{-1}$. The majority of candidates secured two further marks for calculating the critical density using their value for Hubble constant.
- 7 (c) (i) The sketch graphs on Fig. 7.1 were generally poor but candidates did better with their descriptions of the open and closed universe. The evolution of a flat universe was not elegantly described and quite often resembled the description of an open universe.
- 7 (c) (ii) There were many vague answers but stronger candidates had no problems gaining a mark. It is good to report that some candidates were familiar with dark matter, dark energy and the uncertainty problems associated with Hubble constant. A significant number of candidates gave weak answers such as '*the universe is too big to measure its mass and volume*'.
- 8 (a) Very few candidates appreciated that non-invasive techniques reduced the risk of infection. The most popular answer was that patients were not exposed to non-ionising radiations.
- 8 (b) Most candidates scored one or two marks. Many candidates were perplexed by the term *tracer* and thought it was synonymous with barium. It was not uncommon to find the tracers ingested. The marking was relaxed if candidates mentioned tracers being either '*injected or ingested*' in their description. Weaker candidates gave answers to do with X-rays and barium meal. It was good to see candidates being familiar with tracers, such as technetium-99m, and gamma cameras.
- 8 (c) The answers to this question were once again Centre-dependent. About a third of candidates did exceptionally well to score four or more marks. The role of the electron-positron annihilation in the formation of the image was understood by a good number of candidates. Some candidates lost vital marks by referring to gamma waves or rays rather than gamma **photons**. The majority of candidates missed out key details. Candidates are once again reminded for the need for precision in such descriptions. Many candidates would have done considerably better by using bullet points for their descriptions.
- 9 (a) This was a question about ultrasound scanning and sadly, too many candidates wasted their time by giving comprehensive details of how ultrasound was produced and received by the piezoelectric transducer. There were also unnecessary descriptions of why a gel was used between the transducer and the skin. Unfortunately some candidates lost valuable marks because they did not read the question carefully. Most candidates managed to score two or more marks for their descriptions. The majority of these candidates were familiar with ultrasound pulses being reflected at the interface between tissues of different acoustic impedances.

- 9 (b) This was generally a well answered question with most candidates correctly stating that a B-scan produces a multidimensional image or it was a composite of many A-scans.
- 10 (a) The answers from candidates were generally disappointing and lacked precision required for the marks to be awarded. A disappointing number of candidates wrongly referred to a neutron being absorbed by an element or an atom. Examiners did not give any credit for neutrons that were '*hitting*' the nucleus. Examiners were keen to see a neutron being absorbed by the nucleus. As always, examiners allowed a variety of descriptions that conveyed this important bit of physics. Some candidates referred to the nucleus breaking up into '*fragments*' without mentioning that one or more fast-moving neutrons were also emitted. Only a small number of candidates correctly mentioned a slow-moving neutron being absorbed by a nucleus (such as uranium-235), which led to the production of two smaller nuclei and one or more fast-moving neutrons.
- 10 (b) Some candidates misunderstood the question and assumed they were being asked about the production of electrical energy in a nuclear power station. It was clear from candidates' responses that binding energy was poorly understood and quite often confused with mass defect. A disturbing number of candidates thought that the 'binding energy of the two smaller nuclei was less than the binding energy of the original nucleus'. Candidates who gave explanation for the energy in terms of mass changes and $\Delta E = \Delta mc^2$ were generally more successful than those using the binding energy approach.
- 10 (c) Most candidates gave a suitable material for the moderator (e.g. water or graphite) but then went on to incorrectly describe its ability to control the fission reactions by absorbing the neutrons. Weaker candidates opted for either lead or iron as the suitable material for a moderator. Very few candidates appreciated that the neutrons needed to be slowed down in order to increase their chance of causing further fission reactions inside the fuel rods of a nuclear reactor.

G486 Practical Skills in Physics 2

General Comments

The second moderation session of the A2 physics practical skills went smoothly with many centres taking on board the comments made last year. There were less clerical errors this year with most centres using the new 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 new cover sheets. Several centres entered candidates with all three tasks from 2010 and were reminded that this is not permitted.

Many more teachers were annotating the written prose in the evaluative tasks indicating which of the marking scheme points were being credited. This was found to be very helpful by moderators, in determining how the candidate's work had been interpreted.

A small minority of the work sampled showed random ticks, some for statements that were incorrect. A few large centres sent in work that was perfectly marked by one group's teacher and carelessly marked by another group's teacher. It is essential that where there is more than one teacher assessing the work in a centre, internal standardisation takes place.

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 the Qualifications Manager over the past year and were able to clarify their queries.

Qualitative Tasks

General

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 $10t$ value. Some centres allowed full credit for this even though the mark scheme detailed the requirement that $10t$ 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 this year were altered to emphasise 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 lowering the mass into the beaker, as described in the mark scheme).

Task 3 was again the least popular of the three tasks, however, it allowed access to higher level physics. As with last year, the valid numerical test was generally done well and most candidates were able to explain why the wire moves and relate the frequencies involved to resonance. It is important when marking the physics in B1.2, that credit is not given for unexplained statements. For example, a number of centres gave a mark for a statement such as 'It is due to Fleming's Left Hand Rule', with no further explanation.

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 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, although once again the confusion is less frequent.

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 that 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 requirement for 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 when candidates require a second sheet of graph paper, they do not gain a possible advantage in the use of a larger grid.

Many more candidates showed their workings in the calculation of the gradient. There were less 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 of the number of significant figures quoted in the final answer C2.3, still proves a stumbling block. Responses such as 'I quoted my answer to 2 significant figures because that was the least number of significant figures in my data' are not worthy of credit. Candidates must make reference individually to each measurement made in their response.

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.

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.

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.

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 2011/12 were published in June 2011. 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 2011 and 14 May 2012*') 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. The deadline for the receipt of coursework consultancies is six weeks prior to the 15 May. 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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