GCE

Physics A

Advanced GCE **H558**

Advanced Subsidiary GCE **H158**

Reports on the Units

June 2010

HX58/R/10

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

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

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

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CONTENTS

Advanced GCE Physics A (H558)

Advanced Subsidiary GCE Physics (H158)

REPORTS ON THE UNITS

Chief Examiner's Report

Centres have once again made effective use of previous examiners' reports and examination papers. This was particularly noticeable in the G482 paper with its increased mean score. A large cohort of candidates maximised their final AS and A2 UMS marks by re-sitting the AS unit papers.

The quality of analytical work showed some improvement. However, a significant number of candidates, especially at AS-level, remain baffled by algebraic work. The recall of key definitions remains a cause for concern. Definitions lacked robustness and clarity; with even candidates at the top-end suffering from this ailment.

All examination scripts are electronically scanned before being marked by examiners. Most candidates wrote their answers within the scanned zones for each question. Sadly, the legibility of some candidates' work remains a concern. It is sad when the candidates themselves cannot recognise their own numbers, especially powers of ten.

It is good to report that there were fewer omissions of questions. Candidates were also making sensible use of the 'error carried forward' rule in the analytical questions. Candidates scored acceptable marks for the extended writing questions. However, taken as a whole, the answers often lacked structure and the use of scientific vocabulary was weak. Candidates are once again reminded to careful scrutinise the questions before answering.

Most Centres did well to prepare their students for the assessment of practical skills. Sadly, a disappointing number of Centres provided arithmetically incorrect scores for their students. This is easily avoided by doing simple clerical checks on the three tasks or using the spreadsheet provided on Interchange. Some Centres were using their own variations of the official marking schemes. This is not permissible. Centres can ask for clarification of marking points by emailing OCR.

As always, experienced teams of examiners provided accurate and efficient marking. On screen marking of the four theory 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 2010 examination is given below.

G481 Mechanics

General comments

The marks for this paper ranged from 0 to 60 and the mean mark was about 36. The majority of candidates made good use of their time and managed to finish the paper in the time allocated. There were fewer omissions than last session, with most candidates making some attempt to answer all questions. The number of candidates scoring less than 20 marks dropped significantly.

Centres have once again made effective use of past papers, mark schemes and examiners reports. Candidates did marginally better with their definitions and presentation of multi-stage calculations. For some candidates manipulation of equations remains an insurmountable task. It is quite sad to see scripts with mnemonic triangles used unsuccessfully to rearrange equations. A small number of candidates also had problems with correctly transcribing equations from the Data, Formulae and Relationships Booklet. The most frequently occurring error was the density equation written as $\rho = mV$. Most candidates showed a decent understanding of significant figures and rounding-up of numbers.

In this paper, two marks were reserved in Question 4, for correctly using and spelling two technical words. There was a slight improvement in the comprehension of command words (e.g: *state, define, describe*, etc) used in the paper.

Comments on Individual Questions

Question One

Most candidates made a good start by scoring more than nine marks in this opening question.

(a) A surprising number of candidates were unable to score 3 marks. Some of the common errors were 10^{-6} for mega and 10^{-12} for tera. Pico and giga were common errors for 10^{-9}. Sadly, there were inevitable variations of nano such as nana, mini and nini.

(b) The majority of candidates correctly identified the two scalar quantities as *density* and *volume*. The most frequently occurring error was the inclusion of *weight* as a scalar.

(c) Most candidates correctly determined the time taken for light to travel from the Sun to the Earth to be 500 s. A small number of candidates then struggled to convert this into minutes. A few candidates incorrectly manipulated the equation for speed and got an absurd answer of 4.5×10^{19} s (7.5×10^{17} mins).

(d)(i) The modal score for this question was 2 marks. Many candidates correctly identified the forces on the raindrop as weight and air resistance and generally showed a good understanding of terminal velocity. It was good to see that many candidates were familiar with the idea of '*net force = 0*' at terminal velocity. A minority of candidates were unable to distinguish between acceleration and force. Some examples of incorrect responses are:
At terminal velocity, drag is equal to acceleration
Air resistance is equal to 9.81 m s^{-1}.
Gravity is equal to wind resistance.

(d)(ii) The vast majority of candidates scored full marks for showing the direction of the velocity and calculating the magnitude of the resultant velocity. It is good to report that very few candidates forgot to square root their answer. A very small number of candidates added the two velocities to get a resultant velocity of 5.5 m s^{-1}.

Question two

This question produced a range of marks with most candidates scoring more than four marks.

(a) The majority of candidates managed to score two or more marks for their description of experiments carried out by Galileo. Most candidates were aware of either objects being dropped simultaneously from a tall building or objects being rolled down ramps. Most candidates also knew that the objects hit the ground or reached the bottom of the ramp in similar times. Very few candidates realised that all objects had the same acceleration of free fall. The historical inaccuracies did make examiners smile. Here are some misguided accounts of the experiment.
Galileo dropped a hammer and feather on the Moon.
Galileo dropped metal and plastic cannon balls from Eiffel tower / leaning tower of Pizza.
Galileo used F = ma to find the acceleration of free fall.

A disappointing number of candidates thought that all objects reached a '*terminal velocity of 9.81 m* s^{-1}'.

(b)(i) Most candidates correctly used equations of motion and picked up three marks. Sadly, about a quarter of the candidates scored no marks. Such candidates were either incapable of correctly rearranging the equation $s = \frac{1}{2}at^2$ or they tried to fiddle their way to the answer of 9.47 m s^{-2}. The most popular **incorrect** analysis was as follows:

$$v = \frac{0.600}{0.356} = 1.685 \text{ m s}^{-1}$$

$$a = \frac{\Delta v}{t} = \frac{1.685}{0.356} = 4.73 \times 2 = 9.47 \text{ m s}^{-2}$$

(b)(ii) Most candidates knew that air resistance was the main factor for the low value for the acceleration of free fall. A significant number also correctly mentioned the residual magnetism of the electromagnet. A small number of candidates gave erroneous answers such as those shown below.
The acceleration of free fall varied at different points on the Earth's surface.
The distance of 0.600 m was too small for acceleration to reach its top value of 9.81.
The object did not have a chance to reach its terminal velocity.

(b)(iii) There were a variety of answers for the sketch graph. This question was targeted for the candidates at the top end and as such, it discriminated well. About a third of the candidates drew a correct (parabolic) shape and made sure the graph passed through 0.356 s, 0.600 m.

Question three

The modal score for this question was three marks, with a disappointing number of candidates scoring zero for the definition of the *newton* in **(a)**.

(a) Candidates across the ability spectrum struggled to define the *newton* and failed to mention that it was a unit for force. Here are some typical responses:
A newton is the unit for weight found by multiplying mass by 9.81.
This is when a 1 kg mass moves a distance of 1 m.
A newton is the force on 1 kg mass that has acceleration of 1 m $\underline{s^{-1}}$.

(b)(i) The majority of candidates correctly determined the weight of the spaceship. It is good to report that most candidates used 9.81 N kg^{-1} rather than 10 N kg^{-1} in their conversion. In order to avoid transcription errors, candidates are advised to write large numbers in standard form.

(b)(ii) The majority of candidates scored one mark for dividing the force 3.1×10^7 N by the mass of the spaceship and getting an incorrect answer of 16.3 m s^{-2}. Only about a quarter of the candidates realised that the net force of the spaceship was the difference between upward force and the weight of the spaceship. As with previous papers, candidates generally struggled with questions where they have to sort out all the forces acting on an object. Centres are advised to spend some time analysing free-body diagrams to help candidates visualise similar problems.

(b)(iii) Unfortunately, only about half of the candidates managed to secure a mark. A good number of candidates realised that the mass or weight of spaceship decreased as it burned fuel. Some even mentioned the reduction in the gravitational field strength (and hence weight) with height. Some candidates referred to '*g decreases'* – this was not allowed on the basis that *g* was not defined. Answers in terms of air resistance or drag were not allowed. A significant number of candidates thought inertia of the spaceship was responsible for the increase in acceleration with answers such as '*once the spaceship gets moving it is easier to accelerate it'.*

Question four

The modal score for this question was two marks. Candidates struggled with defining *work done* and many were simply defeated by the demands of **(b)(ii)**.

(a) In this question, candidates had to correctly define *work done* by a force and correctly spell either *distance* or *displacement.* Sadly, most candidates failed to gain a mark because of their poor definition and failure to mention 'movement' of force or object. Candidates' struggling with definitions is an unwelcomed trend. Too many candidates defined the *joule* or *moment* of a force. Explanation of work done in terms of energy transfer was not given credit.

(b)(i) Most candidates scored well by identifying the missing terms as '*gravitational potential'* and '*kinetic'*. Most candidates correctly spelled 'kinetic'.

(b)(ii) Many candidates failed to scrutinise the question and ended up using kinematics to solve the problem. A few candidates managed to score easy marks for determining the kinetic energy and gravitational potential energy of the carriage. Some candidates unsuccessfully tried using '$mgh = \frac{1}{2}mv^2$. Only candidates in the upper quartile correctly used

$$\Delta\text{energy} = F \times 510$$

to determine the average frictional force *F*.

Question five

This was a high-scoring question with the majority of the candidates picking up eight or more marks. In spite of high marks, the quality of written text was poor and the use of technical terms was muddled.

(a) In previous papers, candidates have frequently mentioned braking distance as the '*<u>time</u> it takes for the car to stop whilst the brakes are applied*'. Fortunately, the majority of candidates were successful with their definition for braking distance. A small number of candidates ended up defining either *thinking distance* or *stopping distance.*

(b) Most candidates did manage to gain full marks for their extended writing. About a third of the candidates correctly identified two factors but then failed to state how these affected the braking distance. Sadly, too many candidates focussed on the <u>time</u> taken for the car to stop rather than the braking distance. The spellings of some key words were quite poor; for example *breaking distance, hault, break pads, tire,* etc.

(c) Very few candidates scored full marks. Most candidates got a mark for mentioning that seat belts reduced acceleration or it prevented impact with the steering wheel (or windscreen).

(d)(i) About three quarters of the candidates managed to get full marks for this question. Most candidates correctly read the braking distance at 20 m s^{-1} to be 30 m and used this correctly to determine the stopping distance.

(d)(ii) This question discriminated well with about a third of the candidates correctly calculating the braking distance. A few candidates sensibly decided to omit this question in order to focus their attention on the rest of the paper. The most popular incorrect answer was 48 m – this assumed the braking distance to be directly proportional to the speed. Other erroneous answers were 32^2, 1024 m, $\sqrt{32}$ and 5.66 m.

Question six

This question produced a range of marks with candidates scoring eight or more marks.

(a)(i) Half of the candidates scored full marks for their answer of 0.12 Nm. About a third of the candidates forgot to convert the distance of 3.0 cm into metres. A few candidates lost all marks because they doubled their answer of 0.12 Nm to 0.24 Nm.

(a)(ii) This question was devised for candidates at the top end. About a quarter of candidates managed to get two or more marks. Too many candidates assumed that the question was to do with equilibrium of the object, so they used the principle of moments and ended up with '0.12 = 0'. Only a small number of candidates appreciated that that the total moment about point **O** was equal to the torque of the couple (0.12 Nm).

(b) It was good to see succinct answers such as '*net force = 0 and net moment = 0*'. However, the vast majority of answers lacked precision and robustness. An answer such as *'up forces = down forces*' was not allowed.

(c)(i) The majority of the candidates scored full marks by correctly selecting the right equation for density. A few candidates got an answer of 0.81 kg m^{-3} by multiplying the mass of the slab with its volume.

(c)(ii) About half of the candidates gained full marks. It was good to see well presented answers from the vast majority of the candidates. Some solutions took no more than three lines. Inevitably, there were some problems. Some candidates used the mass 45 kg instead of the weight 441 N, failed to realise that the distances 0.150 m and 0.600 m were perpendicular distances and either resolved the weight or the force F.

Question seven

The majority of candidates scored three or more marks for this question. Candidates in the upper quartile picked up most of the marks and showed excellent powers of analysis in **(b)(ii)**.

(a) Most candidates correctly completed the table and there were very few omissions.

(b)(i) A question similar to this has appeared in previous G481 papers, so it was doubly disappointing to see that the modal score was zero. Most candidates failed to qualify their statement of '*permanent extension'* with reference to removal of force or stress. There were too many vague statements, some of which are listed below:
This is when a plastic is deformed past the elastic limit.
A material that shows permanent extension and becomes longer.
A material that does not obey Hooke's law.

(b)(ii) There was no evidence that candidates were short of time. About a third of the candidates secured full marks and about a quarter scored nothing. This question showed a disturbing weakness in manipulating equations.
A disappointing number of candidates correctly started off with

$$E = \frac{FL}{Ax}$$

but then substituted 3.0×10^9 (Pa) for the value of the force. Candidates who started with

$$E = \frac{\text{stress}}{\text{strain}}$$

were generally more successful in getting the answer of 306 N.
The second part of the question proved to be quite a challenge for some candidates. Those who used the breaking stress instead of the stress value 1.20×10^9 Pa were allowed one mark for the incorrect answer of 0.0115 m.

G482 Electrons, Waves and Photons

General comments

Candidates seemed to have sufficient time to complete the paper and weak candidates were able to find sufficient sections to attempt an answer to every question. The performance of the candidates ranged from those with little knowledge and many guesses to very good candidates who showed that they fully understood the physics of the questions. The examination appeared to provide suitable questions to differentiate sufficiently between the broad range of abilities of the candidates. The structure of the paper was such that each candidate was encouraged to demonstrate their knowledge and understanding to the fullest extent by taking one extra small step for the next part of the question. The mean mark for the paper was 50%.

Disappointingly, many candidates did not provide acceptable answers to the definition questions posed in the paper. These questions are to be expected in any paper and provide a good return for the minimal investment of effort in learning a relatively small number of definitions. The overall quality of written English continues to be poor and some basic mathematical skills that would be expected at this level are also lacking. Often candidates lost marks by being unable to rearrange simple equations. There were unfortunate cases of handwriting being so poor that the meaning of the text was uncertain.

Comments on Individual Questions

Question 1

In general the question was done well giving many candidates a good start.

(a) Most candidates were happy with conventional current and electron flow, although some just referred to ‘opposite directions’, scoring zero, a very few wrong way around, more common was 'opposite directions', but on whole well done.

(b) Many candidates scored at least 1 mark, but there were a significant number of incorrect responses. J C^{-1} was the popular alternative wrong answer.

(c)(i) Many quoted Kirchhoff’s First Law; but there were also vague answers referring ‘*to no current lost*’ or ‘*conservation of current*’ or '*current is the same everywhere*' leaving out ‘in a series circuit’.

(c)(ii) The majority of candidates were able to give the correct formula or relationship between resistance, area and length, but often the mathematical manipulation to achieve 72 ohms was very dubious. The vast majority scored the final 2 marks using the resistors in series formula.

(c)(iii) Most candidates scored at least 1 mark for writing down the correct formula (I = Anve), but often incorrectly used the relationship between I, v and A to deduce an incorrect answer of $1x10^{-5}$ m^{-1} s.

Question 2

The numerical parts were generally answered well and error carried forward worked well for the occasional mistake.

(a)(i) Often the descriptions given were not sufficient for 2 marks. A common error was to state that '*230 V passes through the lamp*' and often candidates simply stated that the lamp has a '*25W rating*' or '*25W power*'.

(a)(ii) Most candidates answered this part correctly. The most common incorrect answer was 9.2 ohm, i.e. using 230/25.

(a)(iii) The majority candidates answered this part correctly. However many did not score any marks by quoted the answer or by considering the resistance of the lamp, without qualification, rather than by considering P=VI.

(b) Very few candidates realised that this question was about the change of resistance with temperature, so most of the answers were valueless.

(c)(i) It was disappointing to see so many believing that a kWh is a unit of power rather than of energy.

(c)(ii) There were many power of ten errors, resulting in a very high cost which was not queried.

Question 3

This question created problems for weaker candidates and a few blank spaces started to appear.

(a)(i) Most circuit diagrams were convincing, using the correct circuit symbols. The most common error was drawing the wrong symbol for the variable resistor; a few insisted in connecting a fixed resistor in series with the rheostat - presumably to protect the power supply from short circuit.

(a)(ii) 1 Most candidates correctly stated that V increased as I decreased, and many realised that this occurred when R increased, but only a few of the more able candidates appreciated the link with internal resistance. Many lost the marks that they had already gained with contradictions in their explanations.

(a)(ii) 2 Most candidates answered this part by calculating the power dissipated at A, B and C but mistakes were often made in taking data from the graph.

(a)(ii) 3 The emf was often misread as 1.5 V.

(a)(ii) 4 The popular approach was to use E = V + Ir, but many misread values from the graph or failed to manipulate the formula correctly. Good candidates used of the gradient method taking the x- and y-intercepts, making this question a good discriminator.

(b)(i) Generally well answered with many correctly stating intensity = power/area. A significant number of candidates quoted '*Intensity is proportional to amplitude*^{2}'. The most common incorrect or indeterminate definitions were energy per unit area and power over an area.

(b)(ii) This was well answered by middle to higher ability candidates.

Question 4

Parts **(a)** and **(b)** were answered well by most candidates, but the explanations in the later parts were often weak. It was clear that a larger percentage of candidates had a better understanding of the potential divider circuit by comparison to the question on this topic set last year.

(a) The majority of candidates were able correctly to interpret the graph - as intensity increases, resistance decreases.

(b)(i) This was generally well done, although some stated 9 V or less popularly 6 V.

(b)(ii) Many candidates answered this correctly with the minimum of explanation. However those who attempted to use the potential divider equation often made incorrect substitutions or had difficulty in rearranging the equation.

(c) Most gained the first mark but very few managed to relate successfully the resistance change to voltage change. A common error was to refer to the resistance value rather than the change in resistance.

(d) Answers to this question were often confused with candidates either giving imprecise statements such as ‘the voltage increases’ without specifying which voltage, or by confusing the LDR with the carbon resistor. A number stated incorrectly that the LDR resistance would increase when the carbon resistor resistance falls.

(e) Not many candidates scored both marks. The most common answers were ‘*data logger is very/more accurate*’ and ‘*no human error involved*’ both of which failed to score a mark. Some thought the device would plot a graph directly, not indicating the need for a computer.

Question 5

Most of this question was well attempted although it was apparent that a significant number of candidates had little knowledge of some parts of **(c)** and **(d)**.

(a) Many candidates correctly stated ‘*travels in a vacuum or travels at* 3×10^8 m s^{-1}’ . A common answer given that failed to score, being a general property of transverse waves was ‘*can be polarised*’.

(b) A significant number confused the increasing wavelength of the diagram with increasing frequency, thus giving the answers A radio, C IR, F x-ray. These candidates were awarded 1 mark.

(c)(i) & **(ii)** were answered well. There were powers of ten errors with aerials of astronomical or of atomic dimensions. However the ecf rule still applied between the two parts.

(c)(iii) This question demonstrated that understanding of polarisation has improved. Most candidates were able to score marks although, quite often when describing the orientations, their use of "parallel" and "perpendicular" was contradictory to the experiment. The use of Polaroid and slits appeared in descriptions. Some had the impression that the receiving aerial was some kind of polarising device. This gave rise to some very muddled answers.

(d)(i) A number of candidates produced model answers, but many stated that UV-A had the highest energy or frequency, and a significant number were unaware of the three separate regions trying to answer in general terms about UV, with no comparisons.

(d)(ii) To score the mark scientific terms such as ‘absorb’ or ‘reflect’ were expected; ‘stop’ was not adequate.

(e) It was clear that most candidates had an understanding of the photo-electric effect, but often only one mark was scored. A number of candidates repeated information from the question about intensity not being a relevant factor. The words photon and/or workfunction were often missing and answers were sometimes meaningless by containing unconnected statements.

Question 6

This was often a poorly answered question because it was necessary to use the correct words, in the correct context, in a number of places as will be indicated below.

(a) Most candidates gave correct examples of each type of wave correct, but very few included the word particles/medium in their answers. Many candidates wrote '*direction of wave motion*' not '*travel*', failing to distinguish clearly between the direction of travel of the wave and the direction of the vibration of the wave's particles.

(b) It was clear that most of the candidates were familiar with this experiment and the majority scored at least one mark for stating the wave reflects at the closed end or by referring to the formation of nodes and antinodes as an indication of the presence of a standing wave. As was common with the other written answers in this exam, the quality of written English was often of a poor standard.

(c)(i) Many descriptions of the wave diagram seemed to be with reference to a vibrating string or SHM, e.g speed is greatest at the node position. Very few candidates described the motion of the air molecules as being along the axis of the tube. Most assumed transverse oscillations and others claimed the air molecules travelled down the tube and were reflected from the end. Answers showed a misunderstanding of the difference between maximum displacement and amplitude.

(c)(ii) With the application of the repeated errors system, very often 2 marks were scored by simply stating the positions of the nodes and antinodes in the tube. Some candidates misread the question describing the motion at 0, 0.2 and 0.6 m instead of at 0, 0.2 and 0.4 m.

(d) This question proved to be a good discriminator with the better candidates scoring all three marks. It was common for candidates to indicate a node at the end of the open tube in their sketch.

Question 7

This proved to be a good question for the more able candidates, although **(a)** was not answered well.

(a) Confusion between a line spectrum and an interference pattern was common. Many candidates did not really understand the question and therefore gave a description relating line spectra with energy levels for **(i)** and then were more specific about the properties of emission and absorption spectra in **(ii)**. Most candidates scored one mark for stating 'a series of lines'. Also in **(ii)** many candidates correctly explained that the gas absorbs certain frequencies of light but failed to describe the appearance of an observed absorption spectrum.

(b)(i) & **(ii)** The majority of candidates were able to quote and use $E=hf/\lambda$. Only a few incorrectly used $E=hf$ with the wavelength value for f.

(c)(i) This proved to be a good discriminator with all of the most able candidates scoring three marks. Many answers were given where both lines did not start from energy level A. Another common error was to draw the arrows upwards.

(c)(ii) Many answers were given where candidates simply added or subtracted their two values for the green and violet photon energies. It was clear many candidates had difficulty appreciating this kind of energy diagram. Those who drew the correct lines on the figure generally calculated the correct value for the energy level at A.

(d) The majority of candidates of all abilities were able to quote the correct formula to use and full marks were often scored. Less able candidates made incorrect substitutions, not understanding the meaning of one or more of the symbols in the formula. Powers of ten errors were also common.

G483/01 Practical Skills in Physics 1

General comments

This was the second time that this unit was offered for moderation. Any 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 for the valuable contribution that they have made in making this unit of assessment successful.

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. 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 a ‘cross-moderation’ process. 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.

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.

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.

Centres are advised to use the Practical Skills Handbook (available from the OCR website) to assist in both the preparation of candidates and the marking of the tasks.

Administration

The majority of Centres met the relevant deadlines although one or two Centres were very late; OCR do not guarantee to publish results at the agreed time for work which is submitted late. Moderators found that arithmetic errors occurred in approximately ten per cent of the Centres. It is good practice that Centres should 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 required to submit one type of each task for each candidate. A significant number of Centres did submit all the tasks completed for each candidate; where Centres submitted more than one task of each type moderators returned the sample to the Centre so that the Centre could decide which tasks to submit for each candidate.

A small number of Centres incorrectly submitted tasks from last year. Where a candidate is re-submitting tasks, at least one of the three types of task must be from the current year. Candidates may not under any circumstances re-sit a task. For further advice, Centres should read the "frequently asked questions" document available on Interchange and read the sheet that has been returned with the work.

Communication with Centres regarding the moderation process should ideally occur by email; it is essential that OCR has an up-to-date email address which is regularly checked. It has also produced some automated emails from the moderators. 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. 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. Centres should also include a sample set of results together with any details of any modification to the tasks.

Finally it is essential the Centre Authentication Form is completed and sent to the moderator. Moderators had to ask a 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". A number of Centres marked B1.2 by annotating the scripts with the marking point number from the additional guidance – this aided the moderation process.

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. B1.2 is still generously marked; candidates' answers must be detailed and explanations must be thorough.

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.

Quantitative Tasks

Centres again marked the tasks well although there were a number of answers that were generously credited.

Centres are able to help candidates, who are having difficulties 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. Indices notation should be encouraged, e.g. $1/t^2$ / 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. When significant figures are assessed in the table, each row should be checked and the column ticked if correct or the first incorrect value circled. A mixture of the number of significant figures is allowed as indicated in the additional guidance of the mark schemes.

Graphical work was generally done well. 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 the nearest half square. Often mis-plotted points were very obviously wrong; candidates should be encouraged to check points like this as they finish plotting graphs. The majority of candidates drew their line of best-fit with a fair balance of points. When a candidate asks for another sheet of graph paper, a similar sheet should be issued.

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. 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 since these will 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).

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.

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. In task 1 a very large number of candidates incorrectly used 0.01 s for Δt. 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; candidates do not need to use error bars. Further guidance is given in the practical skills handbook.

For C3.2, candidates are expected to make a relevant point regarding the scatter of points about the straight line of best-fit to comment on the reliability of the experiment.

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 score; detail is needed. Centres should ensure that they follow the mark schemes carefully. Advice may be sought by both email and 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. It was pleasing to see good candidates gain this mark.

Finally

Centres are always welcome to email OCR for clarification. There is also a coursework consultancy service available. 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 the 2008/9, 2009/10 tasks, instructions and mark schemes continue to remain confidential.

G484

General comments

Virtually every area of this unit specification was tested and candidates had ample opportunity to demonstrate their knowledge and understanding of the content. The spread of marks was from 4 to 58 with very few candidates scoring less than one-third of the available marks. Candidates had, generally, been well prepared for this examination paper. Once again, the calculations were generally tackled more successfully than the questions requiring a written explanation. Also, many candidates were again careless in reading the questions and consequently lost marks by failing to respond to the exact wording.

Comments on individual questions

Question 1

(a) A friendly opening question with most candidates scoring at least 1 mark.

(b)(i) This was also found to be very straightforward by the vast majority because it simply required the use of the KE formula (synoptic question based on the AS content). However about 1 in 10 candidates believed that the loss of KE could be determined by subtracting the pre and post collision velocities and using this value in $\frac{1}{2} mv^2$. This naïve approach scored no marks.

(b)(ii) Candidates continued to score well here by correctly determining the force on the ball using formula *force= rate of change of momentum*. About one third of the candidates became confused about whether to add or subtract the momentum before and after the collision suggesting that they do not understand that momentum is a vector quantity.

(b)(iii) Predictably, most candidates realised that equal forces would act on the wall and the ball.

(c)(i) It was somewhat surprising that fewer than a third of candidates were able to state three valid assumptions of the kinetic theory of gases. This is routine piece of theory that is central to a secure understanding of the behaviour of gases.

(c)(ii) Candidates showed a good understanding of molecular collisions being the cause of gas pressure with most candidates scoring at least 2 marks.

Question 2

(a)(i) This was a 'stretch and challenge' question and provided good differentiation with only the most able candidates scoring full marks. These good answers referred to the vertical and horizontal components of the lift force *L*. The best answers labelled an angle on the diagram (although this was not necessary to obtain full marks) and hence avoided an ambiguity by referring correctly to the sine and cosine components of *L* in balancing the weight and providing the necessary centripetal force.

(a)(ii) A straightforward calculation successfully answered by most candidates.

(b) A standard 'proof' stated as a learning outcome on the unit specification for which about two-thirds of candidates score full marks.

(c) The most common outcome, scored by half the candidates, was 1 mark. Another forty percent of candidates scored both marks by referring to the equatorial plane of the geostationary orbit and spelling the words *equatorial* or *equator* correctly.

Question 3

(a) Over two-thirds of candidates could correctly state the two conditions for the acceleration of a body oscillating with simple harmonic motion.

(b) Virtually every candidate scored full marks for showing the graphs for KE and total energy for the oscillating body.

(c)(i) Just over one in ten candidates failed to score this very easy mark. The most common error was to state 0.08m instead of 0.04m.

(c)(ii) This produced better differentiation with about half the candidates scoring both marks and about a quarter scoring zero. Candidates needed to follow the instructions given in the question to *'use Fig. 3.1'* (the energy graph) in order to realise that the maximum KE was 0.018J and hence calculate the maximum speed using $\frac{1}{2} mv^2$. Those that used 18J instead of 18mJ were still able to score 1 mark.

(d)(i) As expected, this produced a variety of answers and again some candidates did not take sufficient notice of the wording of the question which asked for an identification of *'what is oscillating and what causes these oscillations'* . MRI was often quoted as a useful application of resonance but marks could only be scored if reference was made to *radio waves* causing the oscillations and *nuclei* being identified as being the oscillating objects. Only about a third of candidates scored 2 marks and over forty percent scored zero.

(d)(ii) More candidates were able to describe problems caused by resonance with bridges being by far the most commonly mentioned example.

Question 4

(a)(i) Most candidates mentioned Brownian motion but about one in five failed to spell Brownian correctly and hence lost the mark.

(a)(ii) Candidates scored no marks when they referred only to the behaviour of the smoke particles and made no reference to the air molecules. The question was very clear in asking candidates to *'state two conclusions about the air molecules …….'*

(b)(i) A straightforward calculation with most candidates scoring full marks. Inevitably, a significant number of candidates failed to convert 17° C into 290K and there was some confusion about whether to use R (molar gas constant) or k (Boltzmann's constant).

(b)(ii) The large majority knew the meaning of *thermal equilibrium* but about a quarter of the candidates ran into trouble with the calculation by, for example, failing to realise that the volume remains constant. Some also tried to use a temperature of 0°C thereby concluding that the pressure must be zero!

Question 5

(a)(i) Those candidates that did not gain the mark here typically forgot to square the speed of the car.

(a)(ii) Again, most were successfully able to use the formula *work done = force x distance moved* to calculate average braking force but about a quarter of candidates failed to identify the absence of *air resistance* as the most significant assumption made.

(b)(i) Candidates realised that the formula $E = mc\Delta\theta$ was required but some carelessly lost a mark by forgetting that there were 4 brake discs and hence the mass was 4.8 kg and not 1.2kg. A significant number, about 10%, also thought that it was necessary to subtract 273 from their answer to get temperature rise into Kelvin.

(b)(ii) This was another 'stretch and challenge' which again gave rise to the intended differentiation of candidates with only the most able candidates scoring full marks and a minority scoring 3 or more marks. The most significant reason for the temperature rise being lower than the calculated value was the presence of air resistance and an explanation of this was required to score 2 of the available marks. Other sensible suggestions were rewarded and many, for example, were aware that there would be heat lost from the discs brakes as soon as their temperature became significantly above the temperature of the surroundings. A very common response was to refer to energy being lost in the form of sound but since this represents only a tiny fraction of the energy dissipated lost from the brakes it was not credited.

(b)(iii) This was successfully answered by most candidates who correctly suggested using discs of higher specific heat capacity or greater mass as ways of reducing the temperature rise.

G485 Fields, Particles and Frontiers of Physics

1 General comments

The examination seemed to allow the good candidates to show their knowledge and understanding of the material in this course. There was a good range of marks from zero to 94 with a mean of 48. The standard deviation was 19.6. The paper differentiated effectively with all candidates able to demonstrate their knowledge of physics. The examiners who marked the paper considered the paper to be appropriate level for the candidates involved in this A2 course. There was no evidence that candidates were short of time. Very few failed to reach and attempt the last question. The blank responses on this question were generally from the weaker candidates who probably were unable to make any attempt.

There were some very good scripts and the majority of candidates should have gained something from this course. There were a significant number of low scoring scripts. In many of these scripts there were blank responses spread throughout the paper. This suggested a lack of thorough knowledge and preparation by these candidates. These candidates would appear to have learnt virtually nothing during the course. There seemed to be evidence that many candidates had not covered a number of parts of the specification for this unit. In particular questions 2, 5 and 10, where free response was required, seemed to be left blank by a significant number of candidates. These candidates seemed to have had little practice or experience of many parts of the course. Many of the candidates would have improved their marks if they had used appropriate ‘physics’ terms and given more specific answers rather than vague responses.

There was a noticeable fall in the standard of hand writing and clarity of digits. The majority of this problem seemed to be a result of the careless attitude of the candidates. In many cases words and digits were unreadable. It was difficult to distinguish between 3 and 5, 2, 4, 7 and 9, or 6 and 8. In some cases this caused the candidates’ problems as they changed the digits from one line to the next having misread their own writing. If the words cannot be read and the context is lost then marks will not be awarded. Marks cannot be awarded for what should have been written if the digits or words are unreadable.

Question 1

This question produced good differentiation across the ability range but very few candidates achieved full marks.

(a) The majority of candidates gave the correct definition. There were many unacceptable answers given such as charge per volt, coulombs per volt and ability to store charge. Approximately a third of candidates failed to give an acceptable definition.

(b)(i) The calculation was generally completed correctly. The main errors were with the powers of ten and also ignoring the unit given on the answer line.

(ii) The majority of candidates answered this calculation correctly. However, a significant minority substituted the charge value in the expression for energy where capacitance was more appropriate.

(c)(i) This part was generally poorly answered. Very few candidates answered the question and described the effect on the potential difference across the capacitance due to the movement of electrons. The main mark obtained was for the capacitor discharging. As expected only the very good candidate stated that there was an exponential decrease in the potential difference. The vast majority of candidates were unable to describe the correct movement of electrons from the lower plate through the circuit to the top plate of the capacitor. Many stated the movement of electrons as from negative to positive without identifying the plates or suggesting that this was through the external circuit. The answers generally showed a lack of understanding of how the capacitor discharged. Almost half the candidates failed to gain any marks.

(ii) The majority of candidates obtained this mark but there were many answers that described the energy as going to or through the resistor. Very few answers suggested the energy was converted to heat in the resistor.

(d)(i) The majority of candidates used the correct formula for capacitors in parallel. However, there were a significant number who used the formula for capacitors in series even though they had been told in the question that the capacitors were in parallel.

(ii) The good candidates realised that the charge was constant and used this with the total capacitance to calculate the new potential difference. As expected many of the average candidates found this part very difficult. Many of the weaker candidates omitted this part, gave the supply voltage as there answer or divided the supply voltage value by two even though the supply was no longer connected.

Question 2

There was a good distribution of marks on this question with a significant number of the high ability candidates scoring high to full marks. There were a significant minority who obtained five or less marks

(a) The majority of candidates scored at least one mark. A common answer not given credit was 'isotropic'. There were many contradictory answers such static and expanding or infinite and expanding.

(b)(i) The gradient of the graph was calculated correctly by the vast majority of candidates. There were a small minority that misread the axes and there was a very small minority that calculated the inverse of the gradient.

(ii) There was a good number of candidates (almost 50%) who were able to convert the Hubble constant determined in **(b)(i)** into SI units and complete the calculation for the age of the universe. The conversion was beyond many of the average candidates and they tended only to score the mark for the age being the inverse of the Hubble constant.

(c)(i) A significant number of candidates did not convert the value of the Hubble constant determined in **(b)(i)** into SI units for this part. Even the good students who had converted correctly in **(b)(ii)** tended to use the wrong value here. The density obtained for the Universe in this case (8×10^{12} kg m^{-3}) did not seem to cause the candidates to make any comment.

(ii) The majority of candidates were able to give good answers. Marks were often lost due to the answers not being given in sufficient detail. The flat Universe was often not fully described. A significant number of candidates (over 30%) failed to score any marks. Their answers tended not to refer to density at all or not to compare densities with the critical density. Some just stated open, closed and flat without any explanation.

(d) This part of the question produced a good range of marks. There were four marks available and the majority of candidates showed good examination technique and gave four clear points. Some candidates gave great detail of the cosmic background radiation and the temperature being close to 2.7 K. However, many failed to mention that the radiation was in the microwave region or gave any other evidence. Almost half of the candidates scored zero or only one mark.

Question 3

This proved to be a very demanding question. However, there was a good range of marks and the question differentiated well. There were a good number of candidates scoring high marks (almost a quarter scored 12 marks or more). However, there were almost half of the candidates who scored less than 5 marks.

(a)(i) The majority scored at least one mark. There were many candidates who drew poor irregularly spaced lines often without using a ruler. Very few gave the wrong direction and a very small number left this part blank or drew horizontal field lines.

(ii) The vast majority obtained this mark with only a very small number making an error with the powers of ten in the unit conversion.

(b)(i) The calculation was found to be difficult by all but the good candidates. Many stated the answer given but from dubious working and received no credit. The majority of candidates did not know how to relate the kinetic energy gained to the energy provided by the accelerating potential difference and therefore obtained no marks. There were a number of candidates that used the energy gained by the ion as ½ QV instead of QV. There were a significant number of candidates that omitted this part.

(ii) The weaker candidates found this calculation difficult. The majority were unable to relate the electric force to the acceleration of the ion. Many used the electric field strength instead of force. Almost a fifth of candidates omitted this part.

(iii) The majority scored the first mark but many were unable to complete the calculation. Over a third of candidates omitted this last part. There were many who did not realise that the initial velocity was zero. The method for analysing parabolic motion seemed to have been forgotten. A significant number introduced the magnetic field for this part and tried using circular motion equations.

(c) Many of the candidates seemed not to be aware of the method of analysis of the motion of ions through electric and magnetic fields and the velocity selector. However, some candidates did produce the correct relationship between the electric and magnetic fields only to use one of the voltage values instead of the velocity. The average candidate used the wrong quantities in the equations they used. As well as using potential difference values for the velocity they confused force and field strength. The use of circular motion formula was also common in this part. The majority could not equate the two forces from the magnetic and electric fields. Over half the candidates failed to score any marks for this part.

(d) This question was only completed correctly by the very good candidate. The majority seemed to have failed to read the question and described a deflection that was more or less than before. However, there had been no deflection in the previous part. Candidates of high ability gave some well reasoned and pleasing discussions of why the ion would now be deflected downwards.

Question 4

The candidates found this question difficult but there was a good distribution of marks. The good candidates were able to score nine to eleven marks. Very few candidates scored twelve or more marks and there were about a quarter of the candidates who scored four or less marks.

(a) The definition was known by approximately half of the candidates. A significant minority lost the mark by referring to magnetic field strength instead of magnetic flux density.

(b) The calculation was well done by the majority of candidates. The unit was also generally well known. Very few failed to gain at least one mark on the question.

(c)(i) The majority of candidates could not describe the meaning of magnetic flux when related to the coil. Very few were able to relate the component of the magnetic flux density perpendicular to the plane of the coil and the flux. The angle θ was rarely defined or explained. Very few mentioned the significance of the area of the coil in their explanation. Many of the candidates referred to the coil cutting flux and did not answer the question.

(ii) The vast majority of candidates knew Faraday's law but not all stated it correctly in this part. A significant minority made an incorrect statement or left a blank space here only to give the correct version in a subsequent part.

(iii) Almost half the candidates failed to gain any marks for this part. Many considered the maximum e.m.f. to be when there was maximum flux. The candidates showed a clear misunderstanding between flux and rate of change of flux. Other candidates did not refer to the graph and described the variation positions of the coil relative to the magnetic field.

(iv) The majority of candidates failed to score any marks. Only 10% scored both marks. The main errors were not reading the graph correctly, omitting the number of turns or omitting the power of ten for the flux from the graph.

(v) The candidates either scored zero, one or two in almost equal proportions. Many of the candidates did not give a quantitative answer or a clear explanation. A common answer that obtained no credit was that the e.m.f. increased as the flux was cut faster. A surprising number thought there would be no change in the e.m.f. or the maximum e.m.f. would quadruple.

Question 5

The question discriminated well across the average to high ability range. However, over a quarter of the candidates failed to score any marks.

(a) At least a quarter of the candidates failed to give an answer or did not describe magnetic resonance. The remaining candidates produced a good distribution of the marks. There were some very good descriptions from a number of candidates. There were some points that were not given in sufficient detail and these cost the candidates marks. The use of a strong field, the use of radio wave pulses and the switching off of the radio wave pulses were omitted by many of the candidates. There were many descriptions of atoms rather than nuclei. Descriptions also showed that there was confusion between spin and precession. There were also descriptions of the change of state and resonance being caused by changes made to the magnetic field. The idea that relaxation times for the hydrogen nuclei vary in different tissue/materials was poorly expressed by the majority of candidates.

(b) There were again about a quarter of the candidates that were unable to score any marks. Candidates lost marks by stating cost and lack of bone detail as disadvantages. Other misconceptions were the disadvantages caused by the magnetic field such as attracting metal objects and causing a heating effect.

Question 6

This question had a good distribution of marks. More than a third of the candidates scored 5 marks but only about 10% scored the last two marks.

(a)(i) The majority of candidates scored both marks but a significant number did not know the difference between half life and decay constant. The conversion from hours to seconds was either missed out or not carried out correctly by a significant number of candidates.

(ii) The good candidates recognised that the time was three half lives and quickly obtained the correct answer. Others used the exponential decay formula but were not always successful. There was some confusion between activity and the number of nuclei. The majority of candidates scored this mark.

(iii) The majority of candidates were able to score both marks although some made an error with the time conversion. Other candidates obtained the correct answer as their wrong time conversion corrected itself here. There were almost 40% of candidates who were not able to score any marks.

(b) The majority of candidates did not answer the question and gave poor answers that did not relate to the activity or the half life. Very few candidates described the half life as a factor in the disposal of radioactive waste.

Question 7

There was a good distribution of marks. There were over a quarter of the candidates scoring full marks. Almost a quarter of candidates scored zero or one mark. A significant minority showed a complete lack of knowledge of this topic and left sections blank.

(a)
(i)-(ii) Almost half of the candidates scored full marks. The common cause for the loss of marks was for not knowing the symbol for the neutrino. The weaker candidates either got the β^- and the β^+ confused or could not apply the method for balancing these types of equation.

(b)
(i)-(ii) There was a majority of candidates that did not score any marks in this section. A large number did not appear to have covered this work and either left this part blank or did not answer in terms of quarks.

(c) Generally well answered. A significant number of candidates (40%) got this wrong and suggested the strong force or the electrostatic force.

Question 8

There was a good distribution of marks. However, there were a significant number scoring zero or one mark (over a third) and very few scored all of the marks. There seemed to be a lack of understanding of nuclear concepts by many candidates.

(a)(i) A low scoring question. The descriptions given were often too vague with answers often stating the binding energy was different or changed or there was a mass defect or a change of mass. These types of answers are not credit worthy at A2 level.

(ii) The majority of candidates scored zero marks. The common answers were gamma radiation or heat.

(b)(i) The majority of candidates scored this mark. There were many answers that were not clear enough for a mark to be awarded.

(ii) The good candidates scored both marks. The average to weaker candidates did not note that the binding energy given was per nucleon, made arithmetic errors or left the section blank.

Question 9

There was a good distribution of marks. There were over a quarter of the candidates scoring the majority of the marks. Just over a quarter scored zero or one mark.

(a) A majority of candidates calculated the force correctly. There were a number of arithmetic errors made by the weaker candidates and some confused electric field strength with force and used the wrong expression.

(b) The majority of candidates did not state that the strong force had to be attractive to keep the protons together.

(c) A significant number of candidates realised that the protons had to be close together for the strong force to take effect. The explanation of how the protons got this close was often poorly given. The usual comment was that the velocity had to overcome the electrostatic force. This mixture of terms does not explain that the deceleration of the proton by the electrostatic force must not reduce the velocity of proton to zero before it is close enough for the strong force to be attractive.

Question 10

About a fifth of the candidates scored zero on this question. There was an even distribution of marks for the remaining candidates but very few scored the top marks. The knowledge of this topic was very poor by the majority of the candidates. Those that new some of this topic lost marks due to lack of precision and detail in their answers. The majority of answers were below that expected at A level.

(a) Many candidates scored zero on this straight forward piece of book work. The majority of answers did not state the phenomena or were too vague in the description of what precisely was interacting with the X-ray.

(b) There was almost complete separation of candidates between those who could use the given intensity equation and those who could not or made no attempt to do so. About 50% scored zero and about 40% scored all three marks.

(c)(i) Very few candidates were able to explain the principle for image intensifiers. Many candidates discussed contrast media in this part. The candidates who did make some attempt at this question seldom mentioned the idea of electrons being multiplied or the conversion of X-ray photons into an increased number of visible photons.

(ii) A disappointingly answered question for this straight forward description of the use of contrast media. The attempts were generally vague or the section left blank by over half of the candidates. The contrast media were mentioned in terms of attenuation coefficient rather than Z number. The idea that this process was necessary to improve the contrast for soft tissue was rarely mentioned. The name for a contrast media was the mark gained by many of the candidates that scored on this question.

G486 Practical Skills in Physics 2

General comments

This first moderation of the A2 practical skills went relatively smoothly with many centres taking on board comments from the AS moderation of their work last year. A significant number of clerical errors occurred this year which delayed the moderation process. It is advised that centres check both the summation of the best three pieces of each candidate's work as well as the transferring of this mark to the MS1 sheets.

Where in the quantitative tasks, candidates are required to make measurements, it is essential that all raw data is recorded in an appropriately headed table of results.

A small minority of centres did not apply the mark scheme rigidly with a few making up their own. For consistency across centres it is 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 did made contact with the Qualifications Manager over the past year to clarify their queries.

Qualitative Tasks

General:

The qualitative tasks were generally well marked. 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 (this is assessed in the Quantitative Tasks). The graph is 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. Candidates who draw a straight line through a curved trend should be penalised. Likewise the drawing of 'hairy' lines should also be penalised. Further guidance is given in the Practical Skills Handbook.

The standard of graph drawing at A2 must be high. It was not uncommon this year to see 'hairy' lines given credit as well as graphs whose line widths were greater than half of the interval between successive grid lines. The linking of the qualitative observations with coherent communication of their knowledge of physics was more difficult for many candidates and is supposed to be discriminating at the higher boundaries.

In Task 1, it was clear that difficulty was experienced by a number of candidates in determining when the masses came back into phase. In B1.2, there was some confusion as to the difference between t and T in candidates' responses, and in many scripts the word *time* was used interchangeably to refer to both quantities in the same sentence. It would help the award of marks in this section if candidates were encouraged to write the full word for quantities such as T or t in their responses and not just refer to the term as *time*.

Candidates seemed to get their heads around Task 2 and in spite of the complicated introductory steps, achieved well. A number of candidates failed to include in their table of results, the readings taken for the first set of results. Candidates should be encouraged to record **all** measurements taken in their 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 were given credit for this. When marking this, credit should be given for the extra care **that was taken** in order to avoid a potential problem.

Task 3 was the least popular of the three tasks, however, it allowed access to higher level physics. The valid numerical test was generally done well although some responses presented a jumble of numbers. Most candidates were able to explain why the wire moves and relate the frequencies involved to resonance.

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 record all raw data measured in a table of results. It was common to find that raw *t* was recorded as *T* in the table of results, not allowing the tabulating of raw data mark B2.1 or the precision of recording mark B2.2 to be awarded. The mark scheme was clear in the additional guidance on this matter and in order not to disadvantage centres that followed the mark scheme, moderators penalised work given full credit for this omission.

There is still 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.

The line of best fit mark C1.2 was frequently generously marked. 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 mark awarded for the two plots circled only. However in the event that ticks are placed by two easy-to-check 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 scaling.

The use of more than half of the graph paper was marked well. A few centres were 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.)

Candidates should be encouraged to show their workings in the calculation of the gradient. Ideally this means a large triangle should be drawn on their graph. This C1.3 mark should not be awarded if it is unclear whether the readings came from a triangle whose hypotenuse is greater than half or less than half of the length of the line drawn.

The justification of the number of significant figures quoted in the final answer C2.3, was generally not well answered. Candidates must refer to the number of significant figures in each of the quantities contributing to the final answer, not generically to 'the data collected' in order to be given the mark.

Evaluative Tasks

The Evaluative Tasks were found to be challenging by 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 calculation of 'uncertainty' in measurements was generally well done, as was the percentage difference calculation.

In describing the reliability of the experiment (C3.2), credit was found to be given in a minority of cases for answers that refer to repeats being made with no further qualification as to the narrow spread of the measurements.

For C4.1 most candidates were able to gain credit for stating two limitations. It was not uncommon for candidates to be given credit for saying that a limitation was ‘reaction time’ making no further comment as to where in the process this occurred and then to describe an improvement for determining the end point of an oscillation. The C4.2 improvement must be linked to an identified limitation.

The improvement ‘light gates’ without explanation should not score; detail is needed here. Centres should ensure that they follow the mark schemes carefully.

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 pleasing to see good candidates gain this mark.

The Future

As Centres are aware, the Tasks for 2010/11 were published in June 2010. As was originally indicated when the course was introduced, one of each type of task will be replaced each year. The tasks that have been replaced may well be used again in future years so **must** remain confidential. Where tasks are to be used again, it is essential that centres use the new versions and mark schemes as in some cases, subtle changes have been made to reduce ambiguity. These changes have been made to assist candidates in their answers.

The mark schemes for the tasks have also been revised. It is hoped that they will be able to be applied more easily to the tasks.

Centres are always welcome to email OCR for clarification. There is also a coursework consultancy service available. It would be helpful if Centres could 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 previous years’ tasks, instructions and mark schemes continue to remain confidential.

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