Course Report 2016

Subject	Physics
Level	Advanced Higher

The statistics used in this report have been compiled before the completion of any Post Results Services.

This report provides information on the performance of candidates which it is hoped will be useful to teachers, lecturers and assessors in their preparation of candidates for future assessment. It is intended to be constructive and informative and to promote better understanding. It would be helpful to read this report in conjunction with the published assessment documents and marking instructions.

Section 1: Comments on the Assessment

Component 1: Question paper

The question paper performed largely as expected, with a number of questions proving more straightforward or more difficult than anticipated.

Q3(b)	It was anticipated that candidates would find the unfamiliar value of gravitational field strength and the concept of its variation with altitude challenging. Candidates' marks were higher than anticipated.
Q8(a)	The intention was to have this as a straightforward introduction to a question on quantum mechanics. Candidates' marks were lower than anticipated, due in part to a confusion between 'accuracy' and 'precision' in Q8(a)(ii).
Q10(a)(ii)	The physics behind this question is fairly standard, but the wording, while being clear, was unfamiliar to candidates and the marks scored were lower than anticipated.
Q11(b)	The calculation of the wave amplitude using data on wave energy was intended as a 'standard three-marker' type question. Candidates, however, found this more challenging than anticipated.
Q14(c)	This was intended as an 'A' type question, and although the scoring was low (as anticipated), the question did not discriminate between more and less able candidates.
Q15(a)(i)	It was not anticipated that candidates would find this question challenging, but the question operated as an 'A' type.

Grade Boundary marks were adjusted to take account of the above points.

In addition, the scoring for Q16(c) was lower than for the other open-ended question (Q6). This may be due to its position as the last question in the paper, with some candidates failing to spot the large, emboldened instruction to turn over for the next question.

Component 2: Project

The project performed as expected.

In comparison to the Investigation in previous years, additional weighting was given to the Introduction, the Level of Demand of Procedures, the Analysis of Results, and the Discussion and Critical Evaluation of the Project. Traditionally, candidates have found these areas challenging.

References to three sources, rather than one in previous years, are now required for the References mark.

The mark available in previous years for Title, Contents page and Page numbers, which candidates found straightforward, is removed. An additional mark, for Quality of Project has been added, in which candidates scored less well.

The Structure mark is dependent on candidates not exceeding the word count.

Grade Boundary marks were adjusted to take account of the above points.

Section 2: Comments on candidate performance

Areas in which candidates performed well

Component 1: Question paper

Candidates performed well in Q1, 2 and 3, which covered kinematic relationships, angular motion and gravitation.

Q5(b)	Most candidates showed a sound understanding of the equivalence principle.
Q8(b)	Most candidates scored well in this question, showing the ability to calculate the de Broglie wavelength and to use the relationship describing the uncertainty principle. Fewer candidates, however, were able to relate the uncertainty in position of the electron to the separation of the slits.
Q9	Most candidates scored well in the questions involving the motion of the charged particle in the magnetic field.
Q10	Most candidates scored well in the questions involving angular frequency, maximum velocity and energy of a mass moving with SHM.
Q11(a)	Most candidates were able to analyse the sound wave equation to obtain values for f and λ.
Q12	Many candidates showed an understanding of polarisation and the use of polarising filters to block and transmit light.
Q14	Most candidates were able to combine and calculate uncertainties correctly.
Q15(a)(ii)	Most candidates were able to use the appropriate relationship to determine a value for the speed of light.
Q16	Most candidates were able to calculate the moment of inertia, and draw an appropriate graph, and many used the gradient of the line of best fit to determine the moment of inertia.

Component 2: Project

Abstract:	A large number of candidates clearly stated the aim(s) and findings of their project.
Procedures:	Most candidates were able to describe the apparatus and procedures they used in their project. A number, however, did not include labelled diagrams/photographs of sufficient clarity, and did not describe their procedures in past tense passive voice.
Results:	Almost all candidates produced raw data which was sufficient and relevant to the aim(s) of their project.
	Many candidates showed an awareness of scale reading, random and calibration uncertainties and an ability to combine them to estimate the uncertainty in a

measured value. The combination of uncertainties in measured values to find the uncertainty in a derived value was also well done.

Discussion: A large number of candidates were able to write a conclusion which was valid and related to the aim(s) of their project.

An encouraging number of candidates gained the mark for the quality of the project. This mark is intended for a well worked-through project.

Presentation: Most of the candidates' project reports were structured appropriately, with title, contents page and page numbers. Most reports were of an appropriate length, and had cited, retrievable references to at least three sources of information.

Areas which candidates found demanding

Component 1: Question paper

Q4(a),(b) A small number of candidates confused the meanings of the symbol '*r*' in the relationships

$$b = \frac{L}{4\pi r^2} \text{ and } L = 4\pi r^2 \sigma T^4$$

Q7(a) Only a small number of candidates were unable to correctly convert 15 °C into kelvin. A larger number of candidates, however, did not seem to have used the information on the Data Sheet to state the section of the electromagnetic spectrum corresponding to the peak wavelength.

Q8(a)(ii) A number of candidates wrongly described the equivalence principle in terms of the *accuracy* of measurement of momentum and position, rather than the *precision* of measurement of momentum and position.

Q9(b)(ii) A small number of candidates lost marks for ignoring the data on the mass of the deuteron and attempting to estimate its mass by adding the mass of a proton and the mass of a neutron.

Q10(a) Although most candidates were able to define simple harmonic motion, a surprising number were not. In addition, the unfamiliar appearance of the relationship $a = -\omega^2 y$ and the use of the expression $y = A\cos\omega t$ appears to have caught out a number of candidates.

Q10(c) A significant number of candidates were unable to suggest in practical terms how a damping force can be added to an oscillating system.

Q11(b) Many candidates were unable to calculate the wave amplitude from data on wave energy by using the relationship $E = kA^2$.

Q13(b) A number of candidates did not realise that the electrical potential at point Y being zero implies that charge Q_2 is negative.

Q13(c) Although most candidates were able to draw an appropriate shape of electric field pattern, very many did not seem to be aware that the pattern is not symmetrical, and failed to show the necessary 'skew'.

Q14(c) A large number of candidates were not able to suggest an explanation for the student's estimate of reading uncertainty.

Q15(a)(i) Many candidates did not appreciate the need to use the gradient of the line of best fit to determine a value for ε_0. It is not appropriate to use the coordinates of a data point or of a point on the line of best fit.

Q16(c) A significant number of candidates did not show sufficient knowledge of experimental physics to score more than one mark.

Component 2: Project

Introduction: Many candidates did not give an account of the physics behind their project in sufficient depth or at the appropriate level. To score well in this section, candidates are required to demonstrate an understanding of the physics behind their project. In a number of cases, relationships were stated with symbols not defined, or relationships were used without an attempt at justification. A smaller number of candidates attempted to reproduce justifications from referenced sources, but made a number of significant errors in doing so.

Procedures: Only a small number of candidates gained full credit in the 'Level of Demand' section. A significant proportion of the experimental procedures for a number of candidates were not at a level appropriate for Advanced Higher. Some candidates' procedures involved the use of the same experimental arrangements to measure different variables with a limited range of variables and a small number of repetitions. The experimental phase of such projects did not have an appropriate level of demand.

Results: Only a small number of candidates gained full credit in the 'Analysis' section. To score well in this section, candidates are required to show an analysis of their raw data which is appropriate to their project.

A small number of candidates did not include their raw data, showing 'averaged' values only. To gain credit, all data should be included in the report.

Some candidates did not use a graphical analysis where it would be appropriate to do so, but produced a final value by averaging a number of results which had been obtained using different values on the independent variable. Such analysis is incorrect.

A number of candidates produced graphs using Excel or similar software packages which were not of an appropriate size, did not include both major and minor gridlines and used symbols to mark data points which were excessively large. Any graphs included in project reports should have sufficient clarity to allow the reader to check the accuracy of plotting of data points.

A number of candidates did not lay out their analysis clearly. Very often the inclusion of sample calculations clarifies for the reader how the data is being analysed.

Discussion: A number of candidates did not evaluate their experimental procedures in sufficient depth to score well, focusing rather on 'the experiments went well' or 'could have used better equipment' types of evaluation, without identifying the most significant source of uncertainty and suggesting how the uncertainty may be reduced, or commenting on the adequacy of repeated readings, or of the range over which independent variables were altered.

Similarly, in many cases the discussion and evaluation of the project as a whole lacked any depth, and in some instances included repetitions of points made in previous evaluations of procedures.

Presentation: A number of candidates were not awarded the ‘Structure’ mark as their reports were judged to have exceeded the word count.

Almost all candidates included a list of at least three references to sources of information used in the report. A number of candidates, however, did not cite the references at the locations in the report where information from the sources is quoted, and so were not awarded the mark for references.

Section 3: Advice for the preparation of future candidates

Component 1: Question paper

Candidates, in general, were well prepared for the examination, and showed a sound understanding of the majority of the concepts tested in the question paper. Items assessing the ability of candidates to use relationships to determine values were well done. 'Show' type questions, both those requiring candidates to select an appropriate relationship, substitute values and state the final answer, and those requiring an equation to be derived, were also done well.

In answering numerical questions, candidates should be discouraged from rounding numbers prior to the final answer (intermediate rounding). The final answer should be in decimal form, rounded to the appropriate number of significant figures. In the penultimate line of working, a small number of candidates wrote down a truncated version of their final answer. This 'truncated' number was often rounded incorrectly, which meant that the mark for the final answer was not awarded. Candidates should be discouraged from writing down a truncated version of the final answer.

A small number of candidates are using an ellipsis (eg 10·1234…) in intermediate working to indicate that they have not set down all of the figures that they are using. This should be strongly discouraged as candidates are also making mistakes in transcribing the numbers or rounding numbers before the ellipsis.

A number of candidates found difficulty answering questions assessing aspects of experimental technique — estimation of uncertainty, analysis of data, drawing conclusions and evaluation of procedures. Opportunities to practise experimental skills, as part of the project as well as during classwork, should allow improvement in future presentations.

Candidates should be encouraged to take care with the language used when answering questions assessing the knowledge of definitions. While some variation in wording may be acceptable in response to descriptive questions, there is less scope for such variation when answering 'What is meant by…' questions. For example, a number of candidates were unclear of the difference between the meaning of the words 'accurate' and 'precise'.

Many candidates found difficulty with the use of the relationship linking the energy of a wave to its amplitude. Having opportunities to practise this relationship should benefit future candidates.

Component 2: Project

Almost all candidates were aware of the requirements of the project report, and of the information in the 'Instructions for candidate', which is Appendix 1 of the 'Physics Project-report Assessment task' document.

Topic choice

To score well in the project report, each candidate should be encouraged to choose a topic in which the underlying physics and experimental procedures are appropriate for the candidate's ability and appropriate to the level, giving the opportunity to access marks for the Introduction, Procedures, Results and Discussion. Unless a centre is presenting a large number of candidates, there should be no need for candidates in a class or group to be investigating the same topic.

There should be no situations where a whole class is investigating the same topic.

Abstract

Candidates should be encouraged to state a clear aim for their project and to state findings clearly.

If the aim is to measure a physical constant using a number of procedures, candidates should name, or briefly describe each procedure, stating the value obtained for the constant, complete with unit and uncertainty, for each procedure.

If the aim is to compare methods, candidates should be clear which aspect(s) are being compared, for example accuracy, precision, ease of measurement, number of uncertainties etc, rather than stating 'Method A was better than method B'.

If the aim is to confirm a relationship between variables, candidates should be wary of stating a direct proportionality relationship in their findings, if the best fit straight line in the appropriate graph does not pass through the origin.

Introduction

To score well in this section, candidates should be encouraged to demonstrate an understanding of the physics of their chosen topic. Simply stating a number of relationships without any justification, or reproducing information from sources without input from the candidate would not demonstrate full understanding. The inclusion of historical, socio-economic or other 'non-physics' information may be of interest, but does not always contribute towards the demonstration of an understanding of physics, and therefore may be given no credit.

Procedures

Candidates should be encouraged to include clear, uncluttered, labelled diagrams or photographs to help describe the apparatus. Many of the candidates who attempted to sketch their apparatus electronically using drawing packages produced diagrams which lacked the clarity necessary for replication. It may have been quicker and clearer to produce a sketch using pencil and paper, which could then be scanned into the report.

Candidates should describe their procedures, using past tense passive voice, in sufficient detail for replication.

Results

It may help support weaker candidates to appropriately analyse raw data, including uncertainties, if they were given additional opportunities to practise graphical analysis and the estimation and combination of uncertainties as part of classwork.

Presentation

Candidates should be made aware of the criteria, including the maximum number of words, required for the 'Structure' mark to be awarded. Candidates should also be made aware that references to at least three sources of information, listed at the end of the report in a standard form, should be cited at the locations in the report where information from the sources is quoted.

Grade Boundary and Statistical information:

Statistical information: update on Courses

Number of resulted entries in 2015	0

Number of resulted entries in 2016	1923

Statistical information: Performance of candidates

Distribution of Course awards including grade boundaries

Distribution of Course awards	%	Cum. %	Number of candidates	Lowest mark
Maximum Mark -				
A	35.9%	35.9%	690	84
B	24.3%	60.2%	467	72
C	18.8%	78.9%	361	61
D	7.0%	85.9%	134	55
No award	14.1%	-	271	0

General commentary on grade boundaries

- While SQA aims to set examinations and create marking instructions which will allow a competent candidate to score a minimum of 50% of the available marks (the notional C boundary) and a well prepared, very competent candidate to score at least 70% of the available marks (the notional A boundary), it is very challenging to get the standard on target every year, in every subject at every level.

- Each year, SQA therefore holds a grade boundary meeting for each subject at each level where it brings together all the information available (statistical and judgemental). The Principal Assessor and SQA Qualifications Manager meet with the relevant SQA Business Manager and Statistician to discuss the evidence and make decisions. The meetings are chaired by members of the management team at SQA.

- The grade boundaries can be adjusted downwards if there is evidence that the exam is more challenging than usual, allowing the pass rate to be unaffected by this circumstance.

- The grade boundaries can be adjusted upwards if there is evidence that the exam is less challenging than usual, allowing the pass rate to be unaffected by this circumstance.

- Where standards are comparable to previous years, similar grade boundaries are maintained.

- An exam paper at a particular level in a subject in one year tends to have a marginally different set of grade boundaries from exam papers in that subject at that level in other years. This is because the particular questions, and the mix of questions, are different. This is also the case for exams set in centres. If SQA has already altered a boundary in a particular year in, say, Higher Chemistry, this does not mean that centres should necessarily alter boundaries in their prelim exam in Higher Chemistry. The two are not that closely related, as they do not contain identical questions.

- SQA's main aim is to be fair to candidates across all subjects and all levels and maintain comparable standards across the years, even as arrangements evolve and change.