Course Report 2017

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

Summary of the course assessment

Component 1 — question paper

The majority of the questions performed as expected, although a number of questions proved more straightforward or more difficult than anticipated.

Q2(a)(i)(ii)	It was anticipated that candidates would find the labelling of forces acting on the sphere a straightforward task. Many candidates, however, did not appreciate that the direction of the tension in the string acting on the sphere is towards the centre of the circle, resulting in candidates' marks being lower than anticipated.
Q2(b)	The question was intended as a thorough examination of the candidates' understanding of circular motion, but few candidates provided a complete explanation in terms of the tension in the string reducing to zero.
Q4(b)(ii)	A number of candidates did not appreciate that the change in gravitational potential is calculated by subtracting the initial value from the final value. In addition, some candidates were inconsistent in the use of negative signs for gravitational potential and gravitational potential energy, resulting in the marks scored being lower than anticipated.
Q5	Many candidates found the open-ended nature of this question more challenging than anticipated, resulting in responses which often lacked the depth required to demonstrate a good understanding of the physics.
Q6(b)(i)	This was intended as a straightforward question. Many candidates, however, did not correctly identify the position of the star in the H-R diagram, possibly due to unfamiliarity with the logarithmic nature of the scales for luminosity and radius.
Q7(a)	It was not anticipated that candidates would find this question challenging, however the question operated as an 'A' type. This may be due to candidates confusing the higher *frequencies* with the lower *range of frequencies* of the photons emitted by the argon ion laser.
Q8(b)(iii)	This was intended as an 'A' grade question, but many candidates correctly determined the period of oscillation of the mass, resulting in higher marks than anticipated.
Q8(c)	Again, this was intended as an 'A' grade question, but candidates' marks were higher than anticipated.
Q10(a)	Many candidates correctly gave interference as an explanation of the pattern of bright spots, but fewer offered an explanation for the two-dimensional nature of the pattern, resulting in marks that were lower than anticipated.
Q10(b)	Again, many candidates correctly stated that the bright spots in the pattern would be closer together, but fewer gave a full justification in terms of a

shorter wavelength *and* both slit separation and distance to the traffic light remaining constant.

Q11(b)(iv)	Despite the sequencing of the (b)(i), (ii) and (iii) which intended to support candidates in adopting a straightforward approach to answering this question, a number of candidates found the question more demanding than anticipated.
Q12(c)(d)	Many candidates found the unfamiliar context of this question- the velocity selector- more demanding than anticipated.
Q13(c)	Many candidates found the open-ended nature of this question more challenging than anticipated, resulting in responses which often lacked the depth required to demonstrate a good understanding of the physics.
Q14(a)(i)(ii)	Many candidates did not explain the use of the capacitor and the inductor in the circuit in terms of their *reactance*. In addition, a number of candidates confused *resistance* and *reactance.*

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

Component 2 — project

The project performed as expected.

References to three sources, cited within the report and listed at the end of the report in either Vancouver or Harvard style, are now required for the references mark. Many candidates found this challenging.

Grade boundary marks were adjusted to take account of the above point.

Section 2: Comments on candidate performance

Areas in which candidates performed well

Component 1 — question paper

Q1(b)	Most candidates were able to integrate the given expression for velocity to determine the distance travelled.
Q3	Many candidates scored well in questions involving the selection of relationships to calculate quantities related to rotational dynamics.
Q4(a)(i)	Most candidates were able to calculate the tangential velocity of a satellite from the gravitational force acting on it.
Q6(b)(ii)	Many candidates were able to name the type of star from its position on the H-R diagram.

Q6(b)(iii)	Most candidates were able to use the apparent brightness of a star to calculate its distance from Earth.
Q7(b)(i)	Many candidates were able to use the Heisenberg uncertainty principle to solve problems.
Q8(a),(b)(i)	Most candidates showed an understanding of expressions describing simple harmonic motion.
Q10(c)(i), (ii)	Most candidates were able to select a relationship to calculate the wavelength of light in a Young's slits experiment and were able to combine and calculate uncertainties correctly.
Q13(a)	Most candidates were able to select a relationship to determine a value for the time constant for an RC circuit.
Q13 (b)(ii)	Most candidates were able to use data from a voltage-time graph to answer question relating to the time constant for an R-C circuit.

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 that 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 that 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 workmanlike project, well worked through.

Presentation: Most candidates' project reports were structured appropriately, with title, contents page and page numbers.

Maximum word count: The maximum word count was increased to 4500 words. Only a very small number of candidates were penalised for exceeding the maximum word count.

Many candidates produced a high-scoring report with a word count significantly less than the maximum.

Areas which candidates found demanding

Component 1 — question paper

Q2 — A number of candidates were unable to name and show the directions of the forces acting on a sphere moving with circular motion. Only a minority of candidates showed an awareness that the tension in the light string and the weight of the sphere combine to provide the centripetal force necessary for the sphere to move in a circular path.

Q4(b) — Many candidates were unable to state the meaning of gravitational potential or to use the difference between two gravitational potentials to determine the change in potential energy of a satellite. A number of candidates did not refer to '*unit mass*' or '*a mass of 1 kg*' in their statement about gravitational potential, and showed some confusion when determining the difference between two negative values of gravitational potential by subtraction.

Q5 — Only a minority of candidates commented on students' statements on the gravitational pull of the Earth in sufficient depth to demonstrate a good or reasonable understanding at an appropriate level.

Q6(b)(i) — Only a minority of candidates were able to identify the position of a star in the H-R diagram, given the luminosity and the radius of the star.

Q7(a) — Many candidates were unable to make correct predictions about the lifetime of atoms in the excited state, using data from a graph and the Heisenberg uncertainty principle.

Q12(c) — A significant number of candidates were unable to explain the motion of an ion in a region of crossed electric and magnetic fields in terms of the direction and relative magnitude of the electric and magnetic forces acting on the ion.

Q12(d) — Many candidates were unable to explain that the conditions for an ion to pass undeviated through a region of crossed electric and magnetic fields do not involve either the charge or the mass of the ion.

Q13(b)(i) — Many candidates were unable to correctly draw a circuit diagram for a battery, resistor and capacitor connected in series, with a voltmeter measuring the voltage across the capacitor.

Q13(c) — Only a minority of candidates commented on the suitability of a capacitor as the sole energy source for an audio system in sufficient depth to demonstrate a good or reasonable understanding at an appropriate level.

Q14(a)(i)(ii) — A large number of candidates were not able to explain the use of a capacitor and an inductor in a crossover loudspeaker circuit in terms of the variation of the reactance of the components with the frequency of the electrical signal.

Component 2 — project

Introduction: Although an improvement on previous years, a number of 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 used and a small number of repetitions made.

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 that 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 that 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 clarify 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: Only a minority of candidates cited and listed references to at least three sources of information in either Harvard or Vancouver style.

Section 3: Advice for the preparation of future candidates

Component 1 — question paper

Candidates were, in general, well prepared for the examination, and showed a sound understanding of the majority of the concepts tested in the question paper. Items assessing candidates' ability 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.

Opportunities to practise experimental skills, as part of the project as well as during classwork, should support candidates in future presentations answering questions assessing aspects of experimental technique and analysis of experimental data.

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 on what is meant by 'gravitational potential'.

Component 2 — project

Centres are reminded that unless they are 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, irrespective of class size, is investigating the same topic.

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, giving the opportunity to access marks for the Introduction, Procedures, Results and Discussion.

Abstract: Candidates should be encouraged to state a clear aim(s) 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 aspects 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 also be made aware that references to at least three sources of information, listed at the end of the report, should also be cited at the locations in the report where information from the sources is quoted. Both the listing and citing of references should be in either Vancouver or Harvard style. It may assist candidates further if they were made aware of internet sites which offer guidance and support in referencing in Vancouver or Harvard style.

Maximum word count: Candidates should be made aware that the project–report should be between 2500 and 4500 words in length — excluding the title page, contents page, tables, graphs, diagrams, calculations, references, acknowledgements and any appendices. It may be worth stressing to candidates that it is possible to produce a high-scoring report using a number of words closer to the minimum, rather than the maximum permitted number of words.

Grade Boundary and Statistical information:

Statistical information: update on courses

Number of resulted entries in 2016	1923

Number of resulted entries in 2017	1861

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	29.9%	29.9%	556	84
B	26.2%	56.0%	487	70
C	22.1%	78.2%	412	57
D	8.1%	86.2%	150	50
No award	13.8%	-	256	-

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.