Course Report 2018

Subject	Physics
Level	Advanced Higher

This report provides information on the performance of candidates. Teachers, lecturers and assessors may find it useful when preparing candidates for future assessment. The report 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.

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

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 difficult than anticipated.

Q8(c)(i)	It was expected that candidates would find the conversion of pressure to nanopascals, the conversion of speed to kilometres per second, and their substitution into the given relationship a straightforward task. Many candidates, however, did not convert the units correctly, resulting in lower marks than anticipated.
Q8(c)(ii)(B)	Many candidates did not appreciate that the decrease in kinetic energy of the particles is explained by their increase in gravitational potential energy, resulting in the marks scored being lower than anticipated.
Q9(a)(iv)	It was not anticipated that candidates would find this question challenging. Earlier parts of the question relate to the Simple Harmonic Motion of a ball-bearing in the horizontal plane. This question requires candidates to consider the conversion of gravitational potential energy due to its height (vertical displacement) to kinetic energy. Many candidates were unable to link the maximum speed of the ball-bearing to its kinetic energy and thence to its gravitational potential energy, again resulting in lower marks than anticipated.
Q13(b)(iii)	Many candidates were able to calculate the electrical potential at point P due to each of the charged spheres, but a significant number were unable to correctly combine the two potentials to determine the potential at point P due to both charged spheres.
Q14(d)	Many candidates found the open-ended nature of this question more challenging than anticipated, resulting in responses that often lacked the depth required to demonstrate a good understanding of data analysis and of experimental physics.

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

Component 2 — project

The project performed as expected.

Section 2: comments on candidate performance

Areas in which candidates performed well

Component 1 — question paper

Candidates performed well in the following questions:

Q1	Most candidates were able to differentiate correctly the given expression to determine the acceleration of the car, and integrate the expression to find the distance travelled.
Q2	Most candidates were able to calculate centripetal acceleration and centripetal force.
Q3	Most candidates were able to complete calculations involving relationships associated with rotational dynamics.
Q4(a)(ii)	Many candidates were able to convert Astronomical Units (AU) to metres.
Q4(b)	Although set in an unusual context, the majority of candidates selected the correct relationship to calculate the escape velocity of the asteroid.
Q5(b)(i)	Almost all candidates were able to calculate the Schwarzschild radius of the Sun.
Q7(a)(ii)	Almost all candidates were able to calculate the de Broglie wavelength of a neutron.
Q8(a)(i)	Most candidates were aware that the Sun is located in the main sequence region of a Hertzsprung-Russell diagram.
Q10(b)(i)	Most candidates were able to use the wave equation to show the given value of the speed of the electromagnetic wave.
Q12(a)(ii)	Almost all candidates were aware that rotating a single polarising filter will not affect the transmitted brightness of unpolarised light.
Q12(b)(i)	Many candidates were able to calculate the Brewster angle for light reflected from water.

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 or 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 good, competent 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 is 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 considerably less than the maximum.

Areas which candidates found demanding

Component 1 — question paper

Candidates found the following questions more demanding:

Q2(b)(iii) Only a small number of candidates were able to explain, in terms of the forces acting on the second car, why it did not lose contact with the road.

Q5(a) While almost all candidates could correctly calculate a Schwarzschild radius, only a minority were able to explain what is meant by Schwarzschild radius.

Q7(a)(iii) Many candidates were unable to explain the implication of the Heisenberg uncertainty principle in terms of the precision of measurement.

Q8(d) Many candidates were unable to explain why charged particles approaching the Earth follow a helical path. Some candidates answered in terms of *horizontal* and *vertical,* rather than *parallel* and *perpendicular* components of velocity.

Q9(a)(ii) While many candidates were able to obtain an expression for the acceleration of the ball-bearing, fewer were able to relate their expression to the relationship

$$\frac{d^2x}{dt^2} = -kx$$

Q11(c) Few candidates were able to explain why the measurement of multiple fringe separations, rather than just one, is good experimental practice.

Q11(d) While many candidates realised that the expansion of the metal wire contributed to the observation that the fringes get closer together, most did not sufficiently link this expansion to the decrease in fringe separation.

Q12(b)(ii) Only a minority of candidates explained the reduction in glare in terms of the polarising sunglasses acting as an analyser.

Q13(b)(i) Many candidates were unable to use trigonometry to show the given value of electric force between the charges.

Q14(b)(ii) Many candidates did not double the percentage uncertainties in B and r to obtain the percentage uncertainties in B^2 and r^2. In addition, many did not select the appropriate relationship for the combination of uncertainties in measured quantities to find the uncertainty in a final value.

Q14(c) Most candidates did not seem to be aware that the variables in the experiment were B (or I) and r, and so did not select appropriate quantities for the axes of the graph.

Q15(b) Many candidates did not explicitly state the appropriate relationship in this 'show' type question.

Q15(c)(i) Many candidates were unable to substitute correctly into the selected relationship, not realising that the back emf should have a negative value.

Q15(c)(ii) Many candidates did not relate the heating effect in a resistor, and the storage of energy in the magnetic field of an inductor, to the maximum energy delivered to the patient.

Component 2 — project

Introduction

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.

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 and few repetitions. As a rule of thumb, candidates are expected to spend approximately 10 to 15 hours in the laboratory obtaining their experimental data.

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 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 of 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 that were excessively large to mark data points. Any graphs included in project reports should have sufficient clarity to allow the reader to check the accuracy of data point plotting.

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

Discussion
Although the evaluations showed some improvement over previous years, a number of candidates did not evaluate their experimental procedures in sufficient depth to score well. They focused 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 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 repetition 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 question paper, and showed a good understanding of the majority of the concepts tested. Questions 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. Candidates should be reminded, however, that in 'show' type questions, an appropriate relationship, usually selected from the Relationships Sheet, must be explicitly stated.

In answering numerical questions, candidates should be discouraged from rounding numbers prior to the final answer (intermediate rounding). Candidates should also be discouraged from including a penultimate line to their working, showing an unrounded or truncated final value. A number of candidates rounded incorrectly, or truncated the number, leading to errors in the final answer, resulting in the mark for the final answer not being awarded. The final answer should be in decimal form, rounded to the appropriate number of significant figures. Candidates should be strongly encouraged to show only the selected relationship, the substitution and then the answer, including units, to the appropriate number of significant figures.

In class, candidates should be given opportunities, either verbally or in writing, to practise *explaining* concepts and ideas from the course, such as centripetal force, Schwarzschild radius, the Heisenberg uncertainty principle, wave-particle duality or the path followed by a charged particle in a magnetic field.

Opportunities to practise experimental skills, as part of the project as well as during classwork, should support candidates to answer 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 'electric field strength'.

Candidates should be encouraged to make handwriting as clear as possible, especially symbols and letters used in relationships, and numbers used in substitutions and final answers. For example, care should be taken when writing a relationship such as $\omega = \omega_0 + \alpha t$ that the 'alpha' does not appear as an 'a'.

In some questions, the final answer from an earlier part is 'carried forward' for substitution into the relationship. Candidates should be advised that their stated *final answer* should be substituted, and not an unrounded value, which may have been stored in a calculator. This is particularly the case in 'show' type questions, where the final answer is given.

The document *Physics: general marking principles* outlines the principles used in the marking of Physics question papers. Centres are advised to adopt these general instructions for the marking of prelim examinations and centre-devised assessments for any SQA Physics courses.

Component 2: project

Almost all candidates were aware of the requirements of the project, and of the information in the instructions for candidates, which is appendix 1 of the *coursework assessment task* for Advanced Higher Physics.

Topic choice

Centres are reminded that, unless they are presenting a large number of candidates (more than 10), candidates should not be allowed to choose a topic that is being investigated by another candidate. There should be no need for candidates in a small class or group to be investigating the same topic. Centres presenting a larger number of candidates should minimise the number of candidates investigating the same topic. There should be no situations where a whole class, irrespective of class size, is investigating the same topic. Centres are also reminded that candidates must work individually and no group work is allowed.

To score well in the project, each candidate should be encouraged to choose a topic for which the underlying physics and experimental procedures present an appropriate level of challenge and the opportunity to access marks for the introduction, procedures, results and discussion.

Abstract

Candidates should state a clear aim(s) for their project and 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 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 relationship shows direct proportionality in their findings if the line of best fit does not pass through the origin.

Introduction

To score well in this section, candidates should 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 contribute towards demonstrating an understanding of physics, and therefore is likely to be given no credit.

Procedures
Candidates should 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 lacking the clarity necessary for replication. It may have been quicker and clearer to produce a sketch using pencil and paper and scan it into the report. A circuit diagram should support the description of apparatus used in a procedure involving an electrical circuit.

Candidates should describe their procedures, using past tense passive voice, in sufficient detail to allow replication. This includes details, such as the number of repeats, together with the range and interval of the independent variable.

Candidates should be advised to spend approximately 10 to 15 hours in the laboratory obtaining their experimental data.

Results
For data to be considered sufficient, candidates should ensure the number of repeats, and the range and interval of the independent variable, are appropriate for the experiments. Candidates should include all their data in the report, not just mean values. If the volume of raw data is large, it should be included in appendices.

Additional opportunities to practise graphical analysis and the estimation and combination of uncertainties as part of classwork may support appropriate analysis of raw data, including uncertainties.

Presentation
References to at least three sources of information, listed at the end of the report, should also be cited in the report where information is quoted from the sources. Both the listing and citing of references should be in either Vancouver or Harvard style. Many internet sites offer guidance and support in referencing in Vancouver or Harvard style.

Maximum word count
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 is possible to produce a high-scoring report using considerably fewer words than the maximum permitted.

Grade boundary and statistical information:

(Completed by SQA)

Statistical information: update on courses

Number of resulted entries in 2017	1861

Number of resulted entries in 2018	1891

Statistical information: performance of candidates

Distribution of course awards including grade boundaries

Distribution of course awards	Percentage	Cumulative %	Number of candidates	Lowest mark
Maximum mark				
A	30.6%	30.6%	578	87
B	26.9%	57.4%	508	73
C	22.2%	79.6%	419	60
D	8.2%	87.8%	156	53
No award	12.2%	-	230	-

General commentary on grade boundaries

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.

SQA aims to set examinations and create marking instructions which 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.

Therefore, SQA holds a grade boundary meeting every year for each subject at each level to bring 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.

Grade boundaries from exam papers in the same subject at the same level tend to be marginally different year to year. This is because the particular questions, and the mix of questions, are different. This is also the case for exams set by centres. If SQA alters a boundary, this does not mean that centres should necessarily alter their boundary in the corresponding practise exam paper.