Course report 2022

Subject	Physics
Level	Advanced Higher

This report provides information on candidates' performance. 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 appeals.

Grade boundary and statistical information

Statistical information: update on courses

Number of resulted entries in 2022	**2130**

Statistical information: performance of candidates

Distribution of course awards including grade boundaries

A	Percentage	36.2	Cumulative percentage	36.2	Number of candidates	770	Minimum mark required	103
B	Percentage	24.9	Cumulative percentage	61.1	Number of candidates	535	Minimum mark required	82
C	Percentage	19.7	Cumulative percentage	80.8	Number of candidates	415	Minimum mark required	62
D	Percentage	12.3	Cumulative percentage	93.1	Number of candidates	265	Minimum mark required	41
No award	Percentage	6.9	Cumulative percentage	N/A	Number of candidates	150	Minimum mark required	N/A

You can read the general commentary on grade boundaries in appendix 1 of this report.

In this report:

- ‘most’ means greater than 70%
- ‘many’ means 50% to 69%
- ‘some’ means 25% to 49%
- ‘a few’ means less than 25%

You can find more statistical reports on the statistics page of SQA’s website.

Section 1: comments on the assessment

Question paper

The question paper performed as expected. However, there were some candidates who appeared to have been presented at an inappropriate level as they struggled to access most of the questions.

There were a small number of questions that proved more challenging than anticipated: questions 3(c), 6(b), and 8(a)(ii)(B). In particular, question 14 proved more challenging than anticipated. This question tested concepts first introduced in the National 5 course and further developed through Higher Physics and into Advanced Higher.

It was clear that many candidates were unable to answer questions that related to practical work. While it was clear that some candidates had participated in a range of practical work, it was evident that others had little or no experience of practical work and had therefore not developed the necessary knowledge and skills. Practical related skills are necessary to successfully answer some of the questions in the paper.

Project

The project was removed for session 2021–22.

Section 2: comments on candidate performance

Question paper

Questions assessing candidates' ability to select and use relationships to determine values were well done.

'Show' type questions were overall done well.

'Must justify' questions were well-attempted, and most candidates made a good attempt at using physics to explain their answer.

Questions requiring a 'sketch' were attempted by most, but not always with sufficient care.

Question 1(a)(i),(ii)	Most candidates were able to differentiate and integrate the given relationship.
Question 1(b)	Many candidates were unable to sketch a graph showing an increasing acceleration, showing a constant acceleration instead.
Question 2(a),(b)	Most candidates were able to use the angular equations of motion correctly.
Question 2(b)(i)	Many candidates were, at least partially, able to explain why student Y had a greater tangential velocity than student X. Loose terminology was often the reason that candidates didn't access both marks.
Question 2(b)(ii)	Many candidates were unable to justify that student Y had a larger centripetal acceleration in terms of a greater distance to axis of rotation and a constant angular velocity.
Question 3(a)	Many candidates were able to show the moment of inertia of the wheel. Of those that couldn't, not starting with appropriate relationships was a common issue.
Question 3(b)(i)	Most candidates were able to calculate the torque acting on the wheel.
Question 3(b)(ii)	Some candidates were able to determine successfully the magnitude of the frictional torque acting on the wheel.
Question 3(c)	Many candidates did not explain in terms of an increased centripetal force and therefore insufficient friction. Many candidates made incorrect statements similar to 'centripetal force overcoming friction'.
Question 4(a)	Most candidates were able to show the correct value of gravitational potential energy.
Question 4(b)	Some candidates were able to determine the speed of the satellite correctly.

Question 4(c)	Many candidates were unable to determine the total energy of the satellite. Common issues included not adding the kinetic and potential energies or omitting the negative from the potential energy.
Question 4(d)	Most candidates did not recognise that at lower altitudes the friction from the atmosphere was increased. Many incorrectly suggested that the different value of 'g' was responsible for the greater rate of loss of energy.
Question 4(e)	Most candidates were able to substitute into the given relationship and calculate the correct value for r.
Question 5(a)	Most candidates were able to calculate the Schwarzschild radius correctly.
Question 5(b)	Most candidates gave surplus incorrect information rather than just stating that hydrogen fusion stopped.
Question 5(c)	Almost all candidates were able to make a start in determining the surface temperature, with most able to determine the luminosity, and some candidates able to determine the temperature correctly. Issues included omitting powers from the calculation(s).
Question 5(d)	This was the first open-ended question in the paper and candidates found it quite accessible, with most able to gain at least 1 mark. There were some very good answers to this question.
Question 6(a)	Many candidates did not include simultaneity in their statement.
Question 6(b)	Most candidates offered poor explanations with no reference to the Heisenberg uncertainty principle.
Question 6(c)	Many candidates were able to determine the minimum uncertainty in energy of the alpha particle correctly.
Question 7	This was the second open-ended question in the paper. Candidates had more difficulty with this question and many failed to comment on the suitability of the diagram.
Question 8(a)	Most candidates were able to calculate the de Broglie wavelength correctly.
Question 8(a)(ii)(A)	Many candidates were able to explain why the electrons would be suitable.
Question 8(a)(ii)(B)	Many candidates were unable to identify the mass of the neutron being three orders of magnitude greater and hence would still be suitable due to their small de Broglie wavelength compared to the diameter of the atom.

Question 8(b)	Many candidates were unable to answer with a wavelength obtained from the data sheet.
Question 9(a)(i), (ii)	Most candidates were able to determine both the component of velocity parallel and perpendicular to the magnetic field.
Question 9(b)(i)	Most candidates were able to show the value of the magnetic force.
Question 9(b)(ii)(A)	Many candidates were able to calculate the radius of the circular motion correctly.
Question 9(b)(ii)(B)	Many candidates were able to determine the period of the circular motion correctly.
Question 9(b)(iii)	Some candidates were able to determine the pitch of the helical path correctly.
Question 9(c)	Many candidates were able to identify one change to the helical path but only a few could identify two changes. Some candidates stated ‘direction’, despite the question specifying ‘other than direction’.
Question 10(a)	Many candidates were able to state what is meant by simple harmonic motion, although not as many as should be expected for this type of question.
Question 10(b)	Many candidates did not try to use calculus to show the given expression was a solution to the given relationship.
Question 10(c)(i)	Many candidates were able to show the value given for angular frequency.
Question 10(c)(ii)	Many candidates were able to determine the maximum acceleration correctly.
Question 10(c)(iii)	Many candidates were able to access at least 1 mark for the sketch graph. Omitting values for a or drawing a sine curve were some of the issues seen in candidates’ responses.
Question 11(a)(i)	Many candidates were able to calculate the energy of the reflected wave.
Question 11(a)(ii)	Many candidates did not change the sign of the expression in the bracket, to represent the reflected wave.
Question 11(b)	Many candidates were unable to determine the phase difference correctly. Some candidates quoted the unit as ‘rads’ rather than ‘rad’.

Question 12(a)(i)	Many candidates were able to calculate the fringe separation correctly.
Question 12(a)(ii)	Many candidates were able to calculate the absolute uncertainty correctly.
Question 12(b)	Some candidates were able to determine the fringe separation and uncertainty for the student's second method.
Question 12(c)	Some candidates were able to justify, in terms of uncertainty, why more confidence should be placed in the value for (b).
Question 12(d)	Some candidates were able to justify the effect on the fringe separation correctly. Some candidates identified that wavelength had decreased but did not identify that there had been no change to d and D.
Question 13(a)	Many candidates were unable to state what is meant by plane-polarised light. Loose terminology such as 'travels' and 'direction' were common mistakes.
Question 13(b)(i)	Most candidates were able to complete the table of experimental results.
Question 13(b)(ii)	Most candidates attempted drawing the graph and some were able to do so correctly. Issues included forcing the line through the origin, including a unit for $\cos^2$, and attempting to draw a straight line freehand.
Question 13(b)(iii)	Many candidates were unable to determine a value for I_0 correctly. A few candidates omitted an appropriate unit.
Question 13(b)(iv)	Some candidates were able to determine an appropriate angle.
Question 13(b)(v)	Many candidates were unable to identify the y-intercept as the background light intensity.
Question 13(c)(i)	Many candidates were able to suggest a change that would improve the accuracy of measurements of light intensity.
Question 13(c)(ii)	Few candidates could suggest a change that would improve the precision of measurements of light intensity.
Question 14(a)	Some candidates were able to determine the potential difference between the cathode and anode. The content being tested should be familiar from Higher Physics and is then developed further in Advanced Higher.

Question 14(b)	Some candidates were able to sketch the electric field pattern. Common issues included freehand sketching, arrows missing or in the wrong direction, and uneven spacing of lines.
Question 14(c)	Most candidates were unable to explain the curved path of electrons in the electric field. Electrons 'attracted to the positive plate' and 'repelled from the bottom plate' were common poor explanations.
Question 14(d)(i)	Many candidates were unable to show the vertical acceleration of the electrons.
Question 14(d)(ii)	Many candidates were unable to use appropriate relationships to calculate the vertical separation of the plates.
Question 15(a)(i)	Many candidates were able to calculate the magnetic induction in the cable correctly.
Question 15(a)(ii)	Many candidates were unable to determine the magnitude of the force per unit length.
Question 15(b)	Some candidates were able to determine the relative permittivity correctly. A few candidates introduced a unit for relative permittivity and did not realise that for the relationship to hold it would not have a unit.
Question 16(a)	Most candidates were unable to state what is meant by inductive reactance.
Question 16(b)(i)	Few candidates could show how the expression for resonant frequency was obtained. Many candidates did not realise that the inductive reactance and capacitive reactance could only be equated at the resonant frequency f_0, despite the information being given in the question.
Question 16(b)(ii)	Some candidates were able to determine the capacitance correctly. A few candidates missed that the frequencies were given in kHz.
Question 16(c)(i)	Many candidates were able to calculate the capacitance of the capacitor correctly.
Question 16(c)(ii)	Many candidates were able to show that the voltage across the capacitor reduces to 37% after one time constant, by using information from the graph.

Section 3: preparing candidates for future assessment

Question paper

Candidates **must** be given the opportunity to take an active part in a wide range of practical work and evaluate and analyse as appropriate, to develop the necessary knowledge and skills. This should enable candidates to answer questions assessing aspects of experimental technique, analysis of experimental data, and sources of uncertainty. While demonstration of experiments, videos, and computer simulations may be useful additional tools, they cannot replace active experimental work and do not develop the knowledge and skills associated with practical work.

Candidates should be reminded that in ‘show’ type questions, all steps of the calculation or derivation must be shown, starting with a relationship(s), with the correct final answer to gain all the marks. When the answer to a ‘show’ question is used in subsequent parts of a question, candidates should be reminded to use the answer given, not an unrounded value they calculated.

Candidates should be encouraged to use a ruler where required and present sketches in a neat manner.

Candidates should be reminded to use an appropriate scale and not force the best fit line through the origin, when drawing graphs. Active participation in experimental work and subsequent analysis should help with this.

In answering numerical questions, candidates should be strongly discouraged from rounding numbers prior to the final answer (intermediate rounding). Candidates should also be strongly 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. The final answer should be in decimal form, rounded to the appropriate number of significant figures.

Candidates should be given opportunities, either verbally or in writing, to practise explaining concepts and ideas from the course, such as centripetal force, quantum tunnelling, Bohr model of the atom, and the path followed by a charged particle in an electric field.

Open-ended questions from past SQA question papers could provide suitable prompts for candidates to practise explaining some of the more challenging concepts in the course. Candidates should be discouraged from simply stating three pieces of information in an effort to access the 3 marks, as marking of open-ended questions is holistic.

Candidates should be encouraged to take care and use the correct language when answering questions assessing the knowledge of definitions. While some variation in wording may be acceptable in response to descriptive and explanatory questions, there is less scope for such variation when answering ‘state what is meant by...’ questions. For example, a number of candidates were unable to state what is meant by ‘simple harmonic motion’, ‘plane-polarised light’, and ‘inductive reactance’.

Candidates should be encouraged to make handwriting as clear as possible. This is especially true for symbols such as 'a' and 'α' in angular motion relationships.

Candidates should be encouraged to take care when transcribing relationships from the relationships sheet. This is especially true for symbols such as 'a' and 'α' in angular motion relationships. Some candidates were using a in place of α, which is wrong physics.

In the examination, candidates should also be encouraged to refer to the data sheet and to the relationships sheet, rather than trying to remember data and relationships.

The document 'Physics: general marking principles' outlines the principles used in the marking of the 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.

Centres should ensure candidates are entered at an appropriate level.

Appendix 1: general commentary on grade boundaries

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

For most National Courses, SQA aims to set examinations and other external assessments and create marking instructions that allow:

- a competent candidate to score a minimum of 50% of the available marks (the notional grade C boundary)
- a well-prepared, very competent candidate to score at least 70% of the available marks (the notional grade 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 for each course to bring together all the information available (statistical and qualitative) and to make final decisions on grade boundaries based on this information. Members of SQA's Executive Management Team normally chair these meetings.

Principal assessors utilise their subject expertise to evaluate the performance of the assessment and propose suitable grade boundaries based on the full range of evidence. SQA can adjust the grade boundaries as a result of the discussion at these meetings. This allows the pass rate to be unaffected in circumstances where there is evidence that the question paper or other assessment has been more, or less, difficult than usual.

- The grade boundaries can be adjusted downwards if there is evidence that the question paper or other assessment has been more difficult than usual.
- The grade boundaries can be adjusted upwards if there is evidence that the question paper or other assessment has been less difficult than usual.
- Where levels of difficulty are comparable to previous years, similar grade boundaries are maintained.

Grade boundaries from question papers in the same subject at the same level tend to be marginally different year on year. This is because the specific questions, and the mix of questions, are different and this has an impact on candidate performance.

This year, a package of support measures including assessment modifications and revision support, was introduced to support candidates as they returned to formal national exams and other forms of external assessment. This was designed to address the ongoing disruption to learning and teaching that young people have experienced as a result of the COVID-19 pandemic. In addition, SQA adopted a more generous approach to grading for National 5, Higher and Advanced Higher courses than it would do in a normal exam year, to help ensure fairness for candidates while maintaining standards. This is in recognition of the fact that those preparing for and sitting exams have done so in very different circumstances from those who sat exams in 2019.

The key difference this year is that decisions about where the grade boundaries have been set have also been influenced, where necessary and where appropriate, by the unique circumstances in 2022. On a course-by-course basis, SQA has determined grade boundaries in a way that is fair to candidates, taking into account how the assessment (exams and coursework) has functioned and the impact of assessment modifications and revision support.

The grade boundaries used in 2022 relate to the specific experience of this year's cohort and should not be used by centres if these assessments are used in the future for exam preparation.

For full details of the approach please refer to the National Qualifications 2022 Awarding — Methodology Report.

