Course report 2023

Advanced Higher Mathematics of Mechanics

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. You should read the report in conjunction with the published assessment documents and marking instructions.

The statistics in the report were compiled before any appeals were completed.

Grade boundary and statistical information

Statistical information: update on courses

Number of resulted entries in 2022: 276

Number of resulted entries in 2023: 356

Statistical information: performance of candidates

Distribution of course awards including minimum mark to achieve each grade

A	Number of candidates	181	Percentage	50.8	Cumulative percentage	50.8	Minimum mark required	62
B	Number of candidates	54	Percentage	15.2	Cumulative percentage	66	Minimum mark required	52
C	Number of candidates	39	Percentage	11	Cumulative percentage	77	Minimum mark required	43
D	Number of candidates	32	Percentage	9	Cumulative percentage	86	Minimum mark required	33
No award	Number of candidates	50	Percentage	14	Cumulative percentage	100	Minimum mark required	N/A

Please note that rounding has not been applied to these statistics.

You can read the general commentary on grade boundaries in the appendix.

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 and information page of SQA’s website.

Section 1: comments on the assessment

Question paper

The 2023 Mathematics of Mechanics question paper followed a similar structure to last year's question paper. The first 10 questions were generally intended to assess basic techniques and the remaining nine questions were more demanding, involving more problem solving and less familiar contexts.

Overall, the paper performed broadly as expected. Most candidates attempted the vast majority of the questions and fewer candidates than last year provided no response to individual questions.

Questions 1 and 8 proved more challenging than anticipated. This was taken into account when setting the grade boundary.

Section 2: comments on candidate performance

Question paper

The marking team were very positive in their praise for the overall performance of this year's candidates. This is a result of the hard work by candidates and the dedication of their teachers and lecturers, who prepare them so well.

There was a large increase in the number of candidates presented this year. This did not lead to a dilution in quality, which is incredibly encouraging and a tribute to how well centres prepared their candidates.

Question 1: conservation of momentum

Most candidates gained the first 2 marks for the calculations. However, many more candidates than expected did not achieve the final mark because they did not deal with the slightly unfamiliar use of centimetres per second. Many candidates made mistakes when converting between metres and centimetres or simply incorrectly stated the units as metres per second.

Question 3: projectile motion

Most candidates proved the standard formula and applied it in the specific situation.

Question 4(a): calculating velocity vector given displacement vector and time

Although vectors in general proved problematic this year, most candidates answered this question well.

Question 5: integration by substitution

This was the stand-out of several well-answered questions in the mathematical techniques section that did not have a mechanics context. In general, unlike previous years, most candidates handled the change of variable between x and u well.

Question 6: simple harmonic motion

This was a basic simple harmonic motion question. Many candidates achieved full marks.

Question 8: closest approach

This was meant to be an easier question because the column vectors were given and only one of the bodies was moving. In addition, the assumption we were looking for was simply that the whale remained stationary, but many candidates did not communicate this clearly enough.

Question 10(a): equations of motion

Most candidates attempted the initial calculations well.

Question 10(b): equations of motion

Many candidates made mistakes in this question by rounding prematurely. They would have arrived at the correct answer if they had left their interim calculations as exact values.

Question 11: work done with vector motion

Removing vectors from the mandatory content in National 5 and Higher Mathematics in previous years seemed to have a detrimental effect on candidates' understanding of work done with vector motion this year. Many candidates seemed to misunderstand what was required in part (b) particularly.

Question 12: implicit differentiation

Although this question included a context, many candidates attempted it well. They demonstrated clear understanding of the meaning of the gradient, although some candidates missed out on marks for not communicating their choice of k.

Question 13: circular motion in a gravitational context

Most candidates who answered this question correctly used a method that considered Newton's inverse law at the satellite and the surface of the planet and then circular motion at the satellite. The algebraic rather than numeric nature of this question made it more challenging.

Question 14: second order differential equation

Many candidates achieved full marks for this question although the repeated roots in the auxiliary equation had the potential to cause problems.

Question 15: conservation of momentum and energy

Many candidates made errors when answering this question. Most candidates who missed out on marks confused the general formulae for kinetic and potential energy, which involve a mass m, and the formula in the question, which involved masses of m, M, and $M + m$.

Question 16: forces in equilibrium and motion on a rough slope

Many candidates answered this question well, despite the relatively unfamiliar context of the connected masses and the pulley.

Question 17: integration by parts and volume of revolution

Many candidates navigated the combination of two separate techniques impressively.

Question 18: vertical circular motion

As with question 13, the algebraic nature of the question increased the level of difficulty. However, the context of this question was familiar. A few candidates were able to describe the motion after the string went slack. This should be a familiar scenario for candidates.

Question 19(a): Hooke's law

This was a challenging question. Many candidates gained marks in part (a) even if they did not manage to gain marks in part (b).

Section 3: preparing candidates for future assessment

Candidates should have a sound knowledge of the skills listed in the mathematical techniques for mechanics section of the course specification, in or out of a mechanics context.

Candidates could improve in the following areas:

- Rounding, particularly premature rounding, remains an issue. If a candidate can work with exact values they should, as this can help them to avoid rounding issues. Question 10 is a good example of this. Teachers and lecturers should show candidates how to store an exact value in a calculator so they can use it in further calculations. Any rounded answers that candidates write down as part of their working should, as a rule, be to one more significant figure than the final answer. Teachers and lecturers should discourage candidates from rounding an answer of, for example, 2.01 to 2.
- Teachers and lecturers should emphasise the importance of correct notation and nomenclature. For example, if a candidate routinely fails to write 'dx' in integrals, there are situations, such as integration by substitution, where they will definitely miss out on marks.
- Teachers and lecturers should encourage candidates to state units in their final answers where appropriate. Candidates should practise answering questions that feature unusual units and questions that require them to convert between units. Question 1 in this year's paper is a good example of this.
- As highlighted last year, candidates need to be exposed to both numeric and algebraic types of questions. This year, questions 3(a), 13, 15, 18, and 19 all required a non-numeric answer.
- Candidates should practise answering questions that involve circular motion. Teachers and lecturers should highlight the context of gravitation for horizontal circular motion and the completely different approach required for vertical circular motion.
- Teachers and lecturers should emphasise situations where a description or assumption is required. This involves candidates having to clearly articulate their thoughts in words, which is less usual in other mathematics courses.

Appendix: 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 was developed to support learners and centres. This included modifications to course assessment, retained from the 2021–22 session. This support was designed to address the ongoing disruption to learning and teaching that young people have experienced as a result of the COVID-19 pandemic while recognising a lessening of the impact of disruption to learning and teaching as a result of the pandemic. The revision support that was available for the 2021–22 session was not offered to learners in 2022–23.

In addition, SQA adopted a sensitive approach to grading for National 5, Higher and Advanced Higher courses, to help ensure fairness for candidates while maintaining

standards. This is in recognition of the fact that those preparing for and sitting exams continue to do so in different circumstances from those who sat exams in 2019 and 2022.

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 2023 and the ongoing impact the disruption from the pandemic has had on learners. 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 the removal of revision support.

The grade boundaries used in 2023 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 2023 Awarding — Methodology Report.