Course report 2019

Subject	Mathematics of Mechanics
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 post-results services.

Section 1: comments on the assessment

Question paper

The Mathematics of Mechanics question paper comprised 17 questions covering all units appropriately. It was similar in structure to previous question papers, with the first 10 questions designed to allow candidates to show their overall understanding of the principles of the course. The remaining questions were more demanding but were structured to allow candidates to make progress with each question.

The paper proved to be more challenging than expected. Most candidates attempted all questions, suggesting the content was accessible for most candidates within the time allocation. However, total marks obtained were lower than anticipated and this was taken into account when setting grade boundaries.

It is pleasing to see an increasing number of presenting centres this year and that 20% of entries were from new and returning centres, suggesting that the opportunity to study Mathematics of Mechanics is widening.

Section 2: comments on candidate performance

Areas that candidates performed well in

Question 1 — relationship between impulse and momentum and the calculation of magnitude of velocity

Question 2 — differentiation using product, quotient and chain rules

Question 3 — use of calculus with vectors to connect velocity and displacement **but candidates must remember to use constants of integration where conditions are given**

Question 5 — solution of second-order differential equations **but candidates should note that the final answer is an equation of the form** $y = ...$

Question 6(a) — use of moments to find the turning effect of forces

Question 7 — differentiation of logarithmic and trigonometric functions — this was highlighted in previous course reports, so it was very pleasing to see appropriate simplification

Question 9 — equilibrium of a body on a rough slope — this was highlighted in previous course reports as a topic that needed greater rigour

Question 10 — implicit differentiation

Question 13(a) — body moving on a slope (see comments for question 9)

Question 15(a) — simple application of parabolic motion

Areas that candidates found demanding

Question 4 — This question involved the use of the formula for the velocity of a body moving with Simple Harmonic Motion (SHM). The question required candidates to differentiate the formula given in the formula for displacement to access the final 3 marks. Most candidates calculated the values of a and ϖ accurately, but it was disappointing that many candidates could not proceed with the question. The use of this equation had not been tested for several years and serves as a reminder of the importance of being prepared for some original questions in any paper.

Question 11 — The combination of variable force opposing motion, initial conditions and the use of $a = v\frac{dv}{dx}$ led to many mistakes in the solution of this question. In particular, too many candidates wrongly assumed the constant of integration to be zero. This simplified their solution in (a) and meant they could access only 3 of the 5 marks. Use of limits of integration in such questions can prevent this mistake.

Question 12	Motion in a horizontal circle continues to challenge many candidates. Previous course reports highlighted our concern that some candidates are unaware of the forces acting and their direction in this situation. We reiterate the recommendation for a forces diagram to be drawn, and for candidates to understand the context of such motion.
Question 14	Most candidates were able to start their solution to this question, understanding the conservation of energy principle, and it was pleasing to see good manipulation of the algebra involved. However, it was equally disappointing to see a lack of rigour with an inequality from some candidates, while others could not state the condition for a particle to complete the loop.
Question 15	While most candidates were confident tackling projectile questions, the algebra required in (b) to achieve more than 2 of the 5 available marks proved challenging for many. However, many candidates did not attempt part (c), which, as a 'show that…' question should have been achievable.
Question 16	Relative motion in this format has not been tested for several years but is an integral part of the course, as set out in the course specification. The solution required a good diagram to be drawn and appropriate use of trigonometry. Simplification to a right-angled triangle was common and too many candidates did not persevere with parts (b) and (c). Candidates must remember that follow-through marks are always available.
Question 17	It was deliberate to have a short question as the last question and for it to be from the Mathematical Techniques for Mechanics unit. The succinct solution to (a) required a keen recognition of the integral. Part (b) examined an understanding of the connection between displacement and velocity in calculus.

Section 3: preparing candidates for future assessment

Candidates were generally well prepared for the question paper and willing to attempt all questions. Presentation of solutions continues to improve. We can only emphasise the importance of using annotated diagrams in solutions and, in particular, with motion in a horizontal circle, equilibrium or motion on slopes, and with some relative motion questions.

There were fewer issues with rounding in candidate responses to this question paper than in previous years. However, candidates must familiarise themselves with the new instruction.

Where a question asks for a result to be shown, candidates must show a logical and clear justification. They can then use this result in subsequent parts of a question.

Candidates should familiarise themselves with the course specification (available on the subject web page), as this details all the specific skills required and allows candidates to tackle the question paper with confidence. However, candidates must realise that these skills may need to be applied in context, with extended solutions reasoned appropriately. Not all skills are assessed each year, so it is imperative that past papers are not the only preparation for a final assessment.

Understanding Standards material has been updated and is available online. A new specimen question paper has been created to align with the amended course specification for 2019-2020 and beyond. **There are no changes to the content of this course** but there are some subtle changes in the positioning of topics. Candidates, and those delivering the course, can also find an audio presentation that provides an overview of the revised course assessment. Past papers remain relevant and we continue to encourage the use of the analysis grid as a tool to ensure that all the required skills are learned.

Grade boundary and statistical information:

Statistical information: update on courses

Number of resulted entries in 2018	304

Number of resulted entries in 2019	294

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	40.8%	40.8%	120	65
B	14.6%	55.4%	43	54
C	21.4%	76.9%	63	43
D	7.1%	84.0%	21	37
No award	16.0%	-	47	-

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 that allow:

- a competent candidate to score a minimum of 50% of the available marks (the notional C boundary)
- 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 head of service and statistician to discuss the evidence and make decisions. Members of the SQA management team chair these meetings. SQA can adjust the grade boundaries as a result of the meetings. This allows the pass rate to be unaffected in circumstances where there is evidence that the question paper has been more, or less, challenging than usual.

- The grade boundaries can be adjusted downwards if there is evidence that the question paper is more challenging than usual.
- The grade boundaries can be adjusted upwards if there is evidence that the exam is less challenging than usual.
- Where standards 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 to year. This is because the particular questions, and the mix of questions, are different. This is also the case for question papers set by centres. If SQA alters a boundary, this does not mean that centres should necessarily alter their boundary in the question papers that they set themselves.