Course report 2023

Higher Engineering Science

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: 1,184

Number of resulted entries in 2023: 1,245

Statistical information: performance of candidates

Distribution of course awards including minimum mark to achieve each grade

A	Number of candidates	293	Percentage	23.5	Cumulative percentage	23.5	Minimum mark required	74
B	Number of candidates	252	Percentage	20.2	Cumulative percentage	43.8	Minimum mark required	60
C	Number of candidates	250	Percentage	20.1	Cumulative percentage	63.9	Minimum mark required	46
D	Number of candidates	211	Percentage	16.9	Cumulative percentage	80.8	Minimum mark required	32
No award	Number of candidates	239	Percentage	19.2	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 analysis of the question paper showed that it was fair, balanced, and accessible. However, some questions (6 and 10(b)) were more challenging than intended. Evidence showed that some candidates did not answer C-level questions as expected. These aspects were considered when setting the grade boundaries.

Many candidates performed well in areas such as materials calculations, flowcharts, and describing pneumatic circuits. However, some candidates gave non-descriptive answers that lacked the detail required at Higher for some written-response questions.

Some candidates rounded intermediate calculated answers, which made their final answer incorrect. As a result, they did not achieve all of the available marks. However, most candidates gave their final answers to the correct number of significant figures. Many candidates consistently used the π button on their calculators, which led them to more accurate final answers.

This year, many candidates missed out on the mark in 1-mark questions because they made calculation errors. This was unusual.

Assignment

The requirement to complete the assignment was removed for session 2022–23.

Section 2: comments on candidate performance

Areas that candidates performed well in

Question paper

Question 1

Most candidates achieved full marks. They demonstrated a very good understanding of how to draw a digital logic circuit from a Boolean expression.

Question 2(a)

Most candidates achieved full marks. They demonstrated a very good understanding of how to calculate the gain of the op-amp.

Question 2(b)

Many candidates demonstrated a very good understanding of how to determine appropriate resistor values. An acceptable response was any two values with the correct ratio.

Question 3(a)

Most candidates achieved full marks. They demonstrated a very good understanding of how to calculate force from the torque formula.

Question 3(b)

Most candidates demonstrated a very good understanding of how to calculate strain energy from the graph provided. Many candidates did not achieve full marks because they did not convert the extension into metres.

Question 4(b)

Some candidates stated the name of a mechanical method of joining two shafts other than couplings.

Question 4(c)

Many candidates described the function of a bearing in a drive system.

Question 5

Many candidates demonstrated a good understanding of how to complete the control diagram and gained full marks. However, candidates who used the term ‘heater’ did not gain marks because ‘heater’ described the whole system rather than the sub-system (heating element).

Question 7(a)(i)

Although many candidates attempted this non-concurrent force question well, a few candidates did not achieve marks because they did not multiply the forces by the distance from the fulcrum. Many candidates showed an understanding of how to calculate UDLs.

Question 7(b)(i)

Some candidates described at least one role of an environmental engineer with the detail required for a Higher-level response.

Question 7(b)(ii)

Some candidates described at least one positive or one negative economic impact for the academy.

Question 7(c)

Some candidates described at least one example of how a structural engineer would apply calculations in the design phase.

Question 8(a)

Many candidates completed part of the Boolean expression; however, only some candidates provided a full and correct Boolean expression.

Question 8(b)

Many candidates showed a good understanding of calculating the electrical energy into the system, waste energy, and efficiency, but did not achieve all available marks if they did not complete the energy audit diagram.

Question 8(c)

Many candidates demonstrated a good understanding of how to calculate the magnitude of members AB and AE when analysing node A. However, many candidates did not calculate the magnitude and nature of members BD and BC when analysing node B. Only a few candidates gained full or almost full marks.

Question 9(b)

Many candidates demonstrated a good understanding of transistor theory, but a few candidates made errors when finding the voltage over the R_p resistor and used 7.02V or 9V, which resulted in an incorrect final answer. Many candidates did not attempt this question at all.

Question 9(e)

Many candidates identified from the graph that the op-amp was an inverting op-amp.

Question 10(c)

Many candidates demonstrated a good understanding of the operation of the pneumatic circuit. However, some candidates did not describe the function of V_3 when actuated. This was crucial to V_4 being actuated allowing C_B to instroke.

Question 11(a)(i)

Although many candidates attempted this question well and demonstrated a good understanding of materials calculations, some candidates missed out on marks due to simple arithmetic errors. Some candidates rounded their intermediate calculations on the way to finding the diameter of the piston rod, which meant their final answer for the diameter was incorrect.

Question 11(a)(ii)

As with question11(a)(i), many candidates demonstrated a good understanding of materials calculations; however, some candidates missed out on marks due to simple arithmetic errors. Some candidates rounded their intermediate calculations on the way to finding the change in length, which meant their final answer was incorrect.

Question 11(d)

Most candidates demonstrated a very good understanding of the logic diagram and completed the truth table correctly. However, some candidates did not gain a mark because they made an error with the output from the exclusive OR gate.

Question 12(d)

Most candidates demonstrated a good understanding of the system's criteria and completed a correct, or almost correct, flow chart.

Areas that candidates found demanding

Question paper

Question 4(a)

Many candidates did not provide an appropriate advantage of using a flexible coupling over a rigid coupling.

Question 6

Candidates could gain 2 marks for making two descriptive points about one of the amplifiers and a third mark for making one descriptive point about the other amplifier. Although many candidates attempted this question well and described the operation of both amplifiers, a few candidates only described the operation of one amplifier and missed out on marks.

Question 7(a)(ii)

Many candidates either did not attempt this question or they attempted it incorrectly. Many candidates did not use the required trigonometry skills to find the direction of the reaction at A. The correct method involved adding the horizontal and vertical forces and then using Pythagoras' theorem to find the magnitude of resultant force A.

Question 9(a)

Many candidates did not manipulate the voltage divider formula $V_1/V_2 = R_1/R_2$ to find the value of R_1.

Question 9(c)

Most candidates did not attempt this question. Many candidates who attempted this question did not demonstrate an understanding of how the MOSFET operated in the circuit. Most candidates did not calculate the total resistance of the circuit, which they needed to find the drain-source current through the circuit.

Question 9(d)

Most candidates did not attempt this question. Many candidates who attempted this question did not provide an appropriate Higher-level response. Many candidates did not describe that switching pin 6 high turned the motor in the opposite direction.

Question 9(f)

Most candidates did not use identifiable values from peaks and troughs on the graph and therefore calculated an incorrect gain of the op-amp.

Question 9(g)

Most candidates did not attempt this question. Many candidates who attempted this question did not state that the op-amp had saturated or that clipping had occurred.

Question 10(a)

Many candidates did not describe faults in the pneumatic circuit provided.

Question 10(b)

Most candidates did not attempt this question. Many candidates who attempted this question simply stated three faults without describing them.

Question 11(b)

Many candidates did not provide an appropriate Higher-level response. Some candidates did not answer in the context of the question. The question required candidates to describe skills of a mechanical engineer during the design phase.

Question 11(c)(i)

Many candidates did not write the equation for the vertical forces for the node shown in the question. A few candidates did not attempt this question.

Question 11(c)(ii)

Many candidates did not write the equation for the horizontal forces for the node shown in the question. Some candidates did not attempt this question.

Question 11(c)(iii)

Most candidates did not attempt this question. Many candidates who attempted this question did not show the mathematical skill required to use simultaneous equations to calculate the magnitude of the forces F_1 and F_2.

Question 12(a)

Many candidates missed out on marks due to their rounding in intermediate calculations, which meant their final calculated answer was not correct for V_{out}.

Question 12(b)

Many candidates missed out on marks due to their rounding in intermediate calculations, which meant their final calculated answer was not correct for R_f.

Section 3: preparing candidates for future assessment

This course will return to full assessment requirements from session 2023–24 onwards. This means that candidates must complete the question paper and the annually issued assignment.

Question paper

The 2024 question paper will have the same format as the 2023 question paper, and it will sample the same range of content. Teachers and lecturers must ensure that candidates are prepared in all areas from the Higher course specification so that they can fully respond to the question paper.

This year's nodal analysis question again showed that many candidates did not tackle this question in a methodical way when analysing node B. Teachers and lecturers can refer to SQA past paper marking instructions for guidance on nodal analysis.

Assignment

The assignment will return to the Higher Engineering Science course from session 2023–24. The 2023–24 assignment will be published on SQA's secure website in January 2024. It will assess practical and problem-solving skills:

- analysis
- designing a solution
- building a solution
- testing
- evaluation

As was the case in previous years, centres should have the appropriate simulation software to allow candidates to complete certain tasks.

More information and supporting documentation on the full course assessment is available on the Higher Engineering Science subject page. This includes the course specification, past papers (question paper and assignment), specimen assignment and question papers, and previous years' course reports.

Teachers and lecturers should continue to make use of the Understanding Standards website. This resource provides candidate evidence from past question papers and assignments with supporting commentary, presentations, and webinar recordings.

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.