Course report 2022

Subject	Engineering Science
Level	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	**1185**

Statistical information: performance of candidates

Distribution of course awards including grade boundaries

A	Percentage	27.6	Cumulative percentage	27.6	Number of candidates	325	Minimum mark required	71
B	Percentage	21.5	Cumulative percentage	49.1	Number of candidates	255	Minimum mark required	56
C	Percentage	20.2	Cumulative percentage	69.3	Number of candidates	240	Minimum mark required	41
D	Percentage	17.1	Cumulative percentage	86.4	Number of candidates	205	Minimum mark required	26
No award	Percentage	13.6	Cumulative percentage	N/A	Number of candidates	160	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 analysis of, and feedback on, the question paper showed that it was fair, balanced, and accessible. However, candidates found some questions were more challenging than intended, for example, questions 9(c), 9(d)(ii), 9(e)(1), and 9(e)(ii).

While candidates performed well in areas such as materials, calculations, flowcharts, and the description of pneumatic circuits; candidates found questions requiring a detailed written response to be challenging and often provided a non-descriptive answer or lacked the level of detail required at Higher level.

Candidates showed understanding when rounding intermediate calculated answers and the correct significant figures in a final calculated answer. Candidates used the π button on their calculator allowing for a more accurate final answer, all of this was better than in previous years.

Evidence showed that C-grade questions were not answered as well as what would normally be expected. Questions with a single mark were lost by many candidates due to errors that would not normally have been seen in previous years.

All these aspects were considered when setting the grade boundaries at all levels.

Assignment

The requirement to complete the assignment was removed for session 2021-22.

Section 2: comments on candidate performance

Areas that candidates performed well in

Question paper

Question 1(a)(i)

A very good understanding of the elastic range on a stress-strain graph was shown. Most candidates were awarded the full mark.

Question 1(a)(ii)

A good understanding of the plastic range on a stress-strain graph was shown. Many candidates were awarded the full mark.

Question 1(b)(i)

Many candidates had a very good understanding of a stress-strain graph and provided suitable values for Stress and Strain which enabled them to calculate Young's modulus.

Question 2(a)

A very good understanding was shown by most candidates of the electronic circuit provided. Candidates were able to calculate the voltage out from the voltage divider part of the circuit and then use that answer for V_{in} to the inverting amplifier to find $\underline{V_{out}}$ for the given circuit.

Question 2(b)

Many candidates had a good understanding of the knowledge needed to describe how to decrease the gain of the op-amp.

Question 2(c)

Many candidates demonstrated a good knowledge of the op-amp needed to perform the required task and stated the correct op-amp.

Question 3

Although this non-concurrent force question was well attempted by most candidates, marks were lost by a few candidates due to simple arithmetic errors. Candidates showed an excellent understanding of UDLs.

Question 4(a)

Many candidates showed a good understanding that the pulses had to be the same voltage, but a few did not show a correct ratio (Mark to Space), to run the motor at half speed.

Question 6

A very good understanding of the NAND equivalent for the given Boolean equation was demonstrated by most candidates.

Question 7(a)

A very good understanding of how to calculate the energy required to raise the blocks was shown by many candidates.

Question 7(b)

A very good understanding of how to calculate the output power from the generator was shown by many candidates.

Question 7(c)

Although this question was well attempted by most candidates, showing a good understanding of materials and factor of safety, marks were lost due to simple arithmetic errors. Most candidates showed a better understanding of rounding calculations and significant figures in the final calculated answer than in previous years.

Question 8(a)

A very good understanding of flowcharts was demonstrated with most candidates showing knowledge and understanding of the AND / OR function when completing the flowchart.

Question 8(b)

Most candidates showed a very good understanding of the Boolean equation and provided the correct flowchart.

Question 9(a)

Most candidates had a very good understanding of LDR graphs and voltage divider circuits with many candidates giving correct answers in their final calculated value for V_A.

Question 9(b)(i)

Most candidates showed a good understanding of transistor theory, but errors were made by a few when finding the voltage over the base resistor which resulted in an incorrect final answer.

Question 9(b)(ii)

Many candidates had a good understanding of how to calculate the current gain of the transistor, but a few made arithmetic errors.

Question 10(a)

Although this question was well attempted by many candidates, marks were lost by some candidates who did not provide a full Boolean equation. Some candidates provided only parts of the equation.

Question 10(b)

Most candidates had a very good understanding of the Boolean equation and showed skill in drawing the correct logic diagram. A few candidates provided an alternative logic diagram to the marking instruction which was given full credit.

Question 10(c)(i)

Many candidates had a good understanding of the operation of the pneumatic circuit. However, some candidates did not describe the function and the role played by valve E in the circuit.

Question 10(d)(i)

Most candidates had a very good understanding of how to calculate the resistance of the solenoid.

Question 11(a)

Many candidates had a very good understanding of the steps required to calculate the load on the member. However, marks were lost at the start of this question as a few candidates did not calculate the correct area of the member which was needed to gain full marks.

Question 11(b)

Many candidates had a good understanding of the steps required to calculate mechanical power. However, a few candidates lost marks as they did not find 'n' in revs sec^{-1} or the radius of the windlass.

Question 11(c)

Many candidates had a very good understanding of the knowledge, understanding, and skills needed to successfully calculate the magnitude and angle of the force F.

Question 12

A good understanding was demonstrated by many candidates on how to calculate the magnitude and nature of members AB, AC, when analysing node A. However, many found it more difficult in calculating the magnitude of members BC, BD, and CD when analysing nodes B and C. Only a few candidates gained full or nearly full marks.

Areas that candidates found demanding

Question paper

Question 1(b)(ii)

Many candidates incorrectly stated ‘Ultimate Tensile Strength’ rather than ‘Ultimate Tensile Stress’. This question did not perform as expected.

Question 4(b)

Many candidates found this question challenging and did not describe several possibilities that could be adopted to decrease the speed of the motor by using pulse width modulation (PWM).

Question 4(c)

Many candidates found this question very challenging, and evidence showed that they did not know that no loss of torque is an advantage of using PWM over varying the size of the voltage supply.

Question 5

Many candidates did not provide an appropriate Higher-level response. Candidates often provided answers that were not descriptive and were not in the context of materials in the design of the new structure.

Question 7(d)

Many candidates did not provide an appropriate Higher-level response, for example, ‘saves money’ or ‘disturbs wildlife’. Candidates often provided answers that were not descriptive and were of a National 5 level.

Question 7(e)

As with Q7(d), many candidates did not provide an appropriate Higher-level response.

Question 8(c)(i)

Many candidates found this question challenging. Evidence showed that candidates found the mathematical skill of rearranging the V_{out} formula to find V_1 for a difference amplifier challenging. Furthermore, these candidates found it difficult to manipulate the voltage divider formula V1/V2=R1/R2 to find the unknown variable resistor value, R2.

Question 8(c)(ii)

This question did not perform as expected with most candidates unable to describe how ‘increasing the value of the variable resistor’ or ‘decreasing the value of the fixed resistor’ could increase the reference speed of the elevator. Candidates found this question very challenging.

Question 9(c)

Many candidates found this question very challenging with most not achieving more than half marks. Evidence showed that many candidates did not take the information from the stem of the question as the starting point in the description of the circuit.

Many candidates were not able to describe in detail how the circuit operated. On many occasions candidates did not describe the circuit from the point in time when V_A was less than V_B, and how then the circuit operated in terms of input (voltage dividers), process (op-amp/ transistor) and output (relay and motor).

Evidence showed that candidates did not understand how changes to the input changed the process and, therefore, the circuit output. Candidates that were successful could demonstrate in detail the relationship between V_A becoming greater than V_B and how this changed the process and output of the circuit.

Question 9(d)(i)

Many candidates found this question very challenging, and evidence showed they did not know the difference between two-state and proportional control. Many candidates completed the graph incorrectly by showing proportional control.

Question 9(d)(ii)

Evidence showed that most candidates did not understand that the mechanical output of the system was the motor and therefore did not achieve the mark allocated to this question.

Question 9(e)(i)

Many candidates incorrectly stated the type of amplifier and not the type of control.

Question 9(e)(ii)

As with question 9(d)(ii), evidence showed that many candidates did not know the difference between two-state and proportional control and, therefore, could not answer this question.

Question 10(c)(ii)

Most candidates did not provide an appropriate Higher-level response. Candidates often provided answers that were not descriptive or did not describe why a microcontroller-based system is preferred to a fully pneumatic system.

Question 10(d)(ii)

Many candidates did not add the resistance values of the solenoid and the MOSFET together to get 3.7Ω when calculating the current through the MOSFET.

Section 3: preparing candidates for future assessment

Question paper

In session 2022-23, the question paper component will be the same as 2021-22 and will still sample the same range of content. Centres must ensure that candidates are prepared in all areas of the Higher course specification so that they can fully respond to the question paper.

Although there is no assignment for the 2022-23 academic year, it is advisable that centres use the time normally spent on the assignment, to allow candidates to undertake practical work such as simulating electronic circuits. This will reinforce their understanding of these concepts and better prepare them for questions where they are asked to describe the operation of a process, an electronic circuit, or something similar.

The nodal analysis question showed that a few candidates did not tackle this question in a methodical way when analysing Nodes B and C. Centres should refer to SQA past paper solutions for guidance on nodal analysis.

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.

