Course report 2023

Advanced Higher Statistics

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: 138

Number of resulted entries in 2023: 171

Statistical information: performance of candidates

Distribution of course awards including minimum mark to achieve each grade

A	Number of candidates	87	Percentage	50.9	Cumulative percentage	50.9	Minimum mark required	79
B	Number of candidates	27	Percentage	15.8	Cumulative percentage	66.7	Minimum mark required	65
C	Number of candidates	18	Percentage	10.5	Cumulative percentage	77.2	Minimum mark required	52
D	Number of candidates	19	Percentage	11.1	Cumulative percentage	88.3	Minimum mark required	38
No award	Number of candidates	20	Percentage	11.7	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 1

Question 1 of question paper 1 had a higher level of demand than expected for C candidates, specifically questions 1(f), 2(a)(i), 2(a)(ii) and 2(a)(iii). The grade boundaries were adjusted to take account of this.

Question paper 2

Question paper 2 performed in line with expectations, with only questions 7 and 12(a) being of a slightly lower demand than expected. The grade boundaries were adjusted to take account of this.

Section 2: comments on candidate performance

Question paper 1

Question 1(a) Most candidates' responses did not gain both marks. Candidates' comments tended to lack the precision and technical terminology expected in this Advanced Higher course. In addition, many candidates referenced information from Output 1, when the question instructed them to comment on Figure 1.

Question 1(b) Most candidates gained this mark.

Question 1(c) Most candidates gained both marks.

Question 1(d) Only a few candidates gained this mark. In the marking instructions, see note 3 and the commonly observed responses for details of the responses that were not accepted.

Question 1(e) Many candidates gained this mark.

Question 1(f) Only some candidates gained this mark. The main challenge seemed to be the requirement for candidates to make clear reference to both fat or calories and bakery or non-bakery.

Question 1(g) Many candidates gained no marks. This question highlights that many candidates need to be more fluent in the calculation of p-values.

Question 1(h) Most candidates gained at least 1 mark.

Question 1(i) Most candidates gained at least 1 mark, but only some gained all 3 marks. Many responses did not clearly describe how their named sampling method would be conducted.

Question 2(a)(i) Many candidates gained no marks. The main challenge seemed to be the requirement for candidates to refer to the relationship being linear, and to include the contextual descriptions of the two variables.

Question 2(a)(ii) Most candidates gained at least 1 mark. Only some candidates met the requirement to be clear on the order of subtraction ('observed value – fitted value') and to explain what a residual measures.

Question 2(a)(iii) Only some candidates gained both marks. In the marking instructions, see the commonly observed responses for details of the responses that were not accepted.

Question 2(b)(i) Most candidates gained at least 2 marks. Frequent incorrect responses for the third mark involved omitting the square root or mixing up the coefficient and constant: $\ldots = 1.7322 + 19.8203x$.

Question 2(b)(ii) Most candidates gained at least 2 marks.

Question 2(c)(i) Most candidates gained this mark.

Question 2(c)(ii) Most candidates gained no marks. In the marking instructions, see the illustrative scheme that describes the limitations of a least squares regression line (under the stated transformation) when seeking to locate an optimised value.

Question 2(d) Many candidates gained at least 1 mark.

Question paper 2

Question 1(a) Most candidates gained both marks.

Question 1(b) Most candidates gained at least 2 marks. Some candidates' responses incorrectly stated the need to use the central limit theorem, or they checked that the sample size was greater than 20.

Question 1(c) Most candidates gained no marks. In the marking instructions, see the commonly observed responses for the main cause of this. Candidates were not always clear about the distinction between a random variable representing a sample mean and a random variable representing a population.

Question 2 Most candidates gained at least 3 of the 6 marks. The most common errors were the result of candidates not contextualising the assumption and not including 'median' in the hypotheses and/or the conclusion.

Question 3(a) Most candidates gained at least 2 marks.

Question 3(b) Most candidates gained at least 4 of the 6 marks. In the marking instructions, see notes 3 and 4 and the commonly observed responses for details of the responses that were not accepted.

Question 4 Most candidates gained at least 3 of the 4 marks. This question was designed so that calculating the expected frequencies would present the greatest challenge but obtaining the correct critical value for the stated significance level and the required number of degrees of freedom seemed to be more challenging for some candidates.

Question 5(a)(i) Most candidates gained at least 1 of the 2 marks. The greatest challenge for candidates seemed to be not knowing that for a discrete random variable to be valid, its probabilities should sum to one.

Question 5(a)(ii) Many candidates gained all 4 marks. However, there was a large proportion of poorly written formulae for V(X), for example:

$$\mathrm{V}(X)=\mathrm{E}(X)^2-\left[\mathrm{E}(X)\right]^2$$

$$\mathrm{V}(X)=\mathrm{E}\left(X^2\right)-\mathrm{E}(X)^2$$

$$\mathrm{V}(x)=\mathrm{E}\left(x^2\right)-\left(\mathrm{E}(x)\right)^2$$

$$\mathrm{V}(X)=\left(\mathrm{E}x\right)^2-\mathrm{E}\left(x^2\right)$$

In general, if a candidate gained mark •^{6}, they were awarded mark •^{4} by implication. However, if a candidate did not gain mark •^{6}, they could not be awarded mark •^{4} by implication. Awarding mark •^{4} then depended on whether the candidate had clearly and accurately stated the strategy they were attempting to implement. This made the form of their written formula for V(X) pivotal.

Question 5(b) Most candidates gained at least 2 of the 4 marks.

Question 6 Most candidates gained at least 4 of the 6 marks. One notable challenge was correctly calculating the sample standard deviation from the given summary statistics. Some candidates mixed up $z=\dfrac{\mu-\overline{x}}{\dfrac{s}{\sqrt{n}}}$ with $z=\dfrac{\overline{x}-\mu}{\dfrac{s}{\sqrt{n}}}$, and when combined with their critical value, it often led to inconsistent dealing with H_0 and/or an inappropriate conclusion.

Question 7(a) Most candidates gained both marks.

Question 7(b) Most candidates gained at least 4 of the 5 marks.

Question 8 Most candidates gained at least 4 of the 6 marks. However, like question 4, obtaining the correct critical value for a 0.1% level of significance seemed to present the greatest challenge for many candidates.

Question 9(a) Many candidates gained at least 4 of the 6 marks. In the marking instructions, see notes 1, 2, 4, 6 and the commonly observed responses for details of the responses that were not accepted.

Question 9(b)(i) Only some candidates gained this mark. Candidates were expected to state whether the assumption would be appropriate based on a reason. Candidates who only described the shape of the distribution did not gain the mark. Many candidates responded using the descriptive term ‘skew’, and not always successfully. The Advanced Higher Statistics Course Specification does not require candidates to use this term.

Question 9(b)(ii)	In the marking instructions, see notes 1 and 2 for details of how alternative responses were marked. These notes exemplify the expectation for candidates to be consistent with their decisions throughout a solution, so that they may gain any available follow-through marks.
Question 10	Many candidates gained at least 4 of the 6 marks. Like questions 4 and 8, obtaining the correct critical value for a 0.5% level of significance seemed to present the greatest challenge for many candidates. In the marking instructions, see the commonly observed responses for details of the responses that were not accepted.
Question 11	Many candidates gained at least 2 of the 4 marks. In the marking instructions, see the commonly observed responses for details of the responses that could still gain marks.
Question 12(a)	Many candidates gained at least 3 of the 4 marks. Most candidates seemed to find the explanation of why the interval was only approximate to be most challenging. Many candidate responses suggested that they were unaware that a proportion test is built upon a binomial distribution model. Other responses contained incorrect phrasing, such as ‘a normal to binomial approximation’. In the marking instructions, see notes 2 and 3 for more details of the responses that were not accepted.
Question 12(b)	Many candidates gained at least 2 of the 3 marks. In the marking instructions, see notes 2 and 3 for details of the responses that were not accepted.

Section 3: preparing candidates for future assessment

The highest attaining candidates' solutions make consistent and correct use of notation, with clear and legible layout. These solutions:

- follow the correct sequence of steps for all hypothesis tests
- contain either 'reject H_0' or 'do not reject H_0' at the end of hypothesis tests
- contain conclusions that are not too definitive by using phrases such as 'evidence to suggest that...'

However, many candidates' solutions are poorly structured, have low levels of legibility and/or do not use well established standards of notation. This negatively affects how these candidates approach the more complex parts of several questions.

To briefly exemplify standards of notation, here is a small selection of frequently observed, poorly written statements, and their corrected versions.

Incorrect or ambiguous	Correct
$X \sim (50, 0.28)$	$X \sim N(50, 0.28)$
$x \sim \mathrm{P}(4)$ and $\mathrm{P}(x > 5)$	$X \sim \mathrm{Po}(4)$ and $\mathrm{P}(X > 5)$
$\mathrm{V}(T) = \mathrm{E}T^2 - \mathrm{E}(T)^2$	$\mathrm{V}(T) = \mathrm{E}(T^2) - \mathrm{E}^2(T)$
$\mathrm{P}(0.125)$	$\mathrm{P}(event) = 0.125$

Question paper 1 and question paper 2

The following advice may help prepare future candidates for the Advanced Higher Statistics question papers. Teachers and lecturers should:

- encourage candidates to write all descriptive statements and hypotheses with a high degree of care in both their precision and accuracy
- encourage candidates to describe shapes of distributions using terminology that they understand
- encourage candidates to clearly define all random variables, including the correct notational use of a 'bar' when working with sample means
- ensure that candidates can accurately write down all algebraic formulae, with the correct ordering of terms and the correct positioning of any brackets and/or exponents
- provide opportunities for candidates to practise writing down detailed, contextualised descriptions of how to conduct each of the random sampling methods
- ensure that candidates can write down clear descriptions and definitions of concepts that they may see mainly presented in an algebraic form (for example distributions of sample means, residuals)

- aim to increase candidates' abilities in accurately calculating p-values for both one-tailed and two-tailed tests
- ensure that candidates use a variety of different significance levels during learning and teaching for all hypothesis tests. Depending on the information available to candidates for the test they are performing, these could include significance levels of 0.05%, 0.1%, 0.5%, 1%, 2%, 2.5%, 5% and 10%
- ensure that candidates know how to make valid comments about the patterns that can be observed in a residual plot. In particular, which patterns do, and do not, provide evidence that the assumption of the variance of the residuals is constant, or that the expectation of the residuals is zero
- ensure that candidates are comfortable with the calculations and presentation of least squares regression equations, especially when dealing with transformed data
- ensure that candidates know why $\mathrm{P}(X \geq n)$ is not equal to $1-\mathrm{P}(X \leq n)$ where X is a discrete random variable and n is an integer
- ensure that candidates know that the central limit theorem is not required if the population is either already known to be normally distributed or assumed to be normally distributed
- ensure that candidates know about the underlying binomial model behind a proportion test, so that they understand the need for approximating a binomial distribution with a normal distribution

Teachers, lecturers and candidates can refer to the detailed marking instructions for the 2023 question papers on SQA's website. These illustrate the communication requirements for questions on, for example, describing the location and spread of data using technically appropriate vocabulary, approximating binomial distributions with the normal distribution, conducting tests on the mean difference, and working with formula for a confidence interval.

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.