Course report 2022

Subject	Statistics
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 appeals.

Grade boundary and statistical information

Statistical information: update on courses

Number of resulted entries in 2022	140

Statistical information: performance of candidates

Distribution of course awards including grade boundaries

A	Percentage	40.6	Cumulative percentage	40.6	Number of candidates	55	Minimum mark required	73
B	Percentage	26.1	Cumulative percentage	66.7	Number of candidates	35	Minimum mark required	63
C	Percentage	12.3	Cumulative percentage	79.0	Number of candidates	20	Minimum mark required	53
D	Percentage	9.4	Cumulative percentage	88.4	Number of candidates	10	Minimum mark required	43
No award	Percentage	11.6	Cumulative percentage	N/A	Number of candidates	15	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 1

Question 1 of paper 1 had a higher level of demand than expected for grade A candidates. The level of demand was also slightly higher than expected for grade C candidates. The grade boundaries were adjusted to take account of this.

Question paper 2

Paper 2 performed in line with expectations, with only question 5(b) being of a slightly higher 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 gained the first mark, and many gained the second mark.

Question 1(b) Many candidates gained no marks, with only a few gaining both marks.

Question 1(c) Many candidates gained half of the marks. The marks available for descriptions were done better than those available for explanations. Some candidates chose to describe the distribution of each decade's data, which gained no marks because trends across all three decades were expected to be described.

Question 1(d) Only a few candidates gained full marks, with mark 13 of question 1(d)(i) and mark 14 of question 1(d)(ii) being the most challenging.

Question 1(e) Only a few candidates gained full marks.

Question 1(f) Many candidates gained this mark.

Question 2(a) Some candidates gained full marks with mark 2 being the most challenging.

Question 2(b) Most candidates gained this mark.

Question 2(c) Most candidates gained at least the first mark.

Question 2(d) Many candidates gained both marks.

Question 2(e) Many candidates did this well, but only some gained full marks. Many candidates did not attempt to show the calculation for the p-value.

Question 2(f) Only some candidates gained this mark.

Question paper 2

Question 1 Many candidates did well on this question but only some gained full marks by ensuring that their conclusion was not too definitive or emphatic.

Question 2(a) Most candidates gained this mark.

Question 2(b) Most candidates gained this mark.

Question 2(c) Many candidates gained both marks. There was a noticeable number of candidates who, incorrectly, decided to add the probabilities.

Question 2(d) Many candidates gained full marks, with the most common error occurring when $\mathrm{P}(X+Y>5)$ was thought to be equal to $1-\mathrm{P}(X+Y\leq 4)$.

Question 3 Many candidates gained full marks, with the most common error arising from incorrect probabilities in the distribution table of T that seemed to come from candidates not appreciating that two cards were being selected without replacement.

Question 4(a) Many candidates gained full marks.

Question 4(b) Some candidates gained full marks, with the most frequent loss arising from either missing, or incorrectly applying, continuity corrections.

Question 5(a) Most candidates did not gain this mark. A frequent incorrect response was referencing 'independence' in some manner.

Question 5(b) Many candidates struggled to gain more than half the marks for this question. Many candidates performed either parametric or non-parametric tests for non-paired data. It seemed that question 5(a) was incorrectly understood by many candidates to suggest that no form of t-test was eligible in part 5(b).

Question 6(a) Many candidates only gained 1 of the marks. In general, these candidates made reference to the 'residuals being near zero' [sic] rather than fully describing the plot's shape and the subsequent implication on the residual variance.

Question 6(b) Many candidates gained either 3 or 4 marks for this question.

Question 7(a) Many candidates gained no marks. A frequently observed incorrect method involved 'working backwards from the answer'.

Question 7(b) Many candidates gained at least 3 marks, but only a few gained all 4 marks. Candidates often omitted the correct verification calculations, which suggested that they had not fully appreciated the two-part instruction in the question.

Question 8(a) Most candidates gained full marks.

Question 8(b) Most candidates gained full marks, but often a clear strategy was hard to discern, such as those illustrated by marks 4 and 7 of the marking instructions.

Question 9(a) Most candidates gained no marks as their response was not sufficiently clearly phrased in terms of the distribution of the sample mean.

Question 9(b) Many candidates gained at least 3 marks, but only a few gained all 4 marks. The further assumption (mark 7) was either omitted or candidates made reference to populations being normally distributed.

Question 10(a) Many candidates gained at least 4 out of 7 marks. Marks 1 and 7 were the most challenging for candidates. A lot of candidates performed a hypothesis test on β, which is a measure of the slope parameter, and not linear association. Many candidates also struggled to include reference to the independence of the **pairs** of observations.

Question 10(b) Most candidates gained this mark.

Question 11(a) Most candidates gained at least 1 mark for 11(a)(i), but many candidates did not write a comparative comment on what the diagram showed. Many chose instead to describe each sample separately, or to calculate further statistics.
Many candidates performed well in 11(a)(ii), correctly phrasing their conclusion in terms of the difference of median reaction times. However, a noticeable number of candidates also ranked the data and calculated the same rank sum (of 89) as that already given in the question.

Question 11(b) Some candidates gained no marks as they did not know how to deal with the difference of two independent normal random variables. Furthermore, a few candidates' solutions suggested that they had not appreciated that a slower reaction time is actually a greater number.

Section 3: preparing candidates for future assessment

The majority of candidates were well prepared and attempted all questions. The highest attaining candidates' solutions made consistent and correct use of notation, with clear and legible layout.

Skills that were well demonstrated by the majority of candidates were:

- the calculation of probabilities for discrete and continuous distributions, by manual calculation, using the Data Booklet or with a graphing calculator
- the calculation of both the mean and variance of a discrete distribution
- following the correct sequence of steps for all hypothesis tests
- obtaining the correct critical values and subsequently making the correct decisions about whether to reject, or not to reject H_0

However, many candidates' solutions were poorly structured, had low levels of legibility and/or did not use well established standards of notation. These all had a negative impact on how many of those candidates were then able to tackle 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 papers 1 and 2

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

- ensure candidates know the correct conventions and when to use capital letters, lower-case letters, Roman letters and Greek letters
- ensure that when candidates mention a population, they should always clarify the nature of the population, using the context of the question
- ensure that when candidates refer to any mean, they clearly communicate whether it is a sample mean or a population mean. Similarly for other measures, such as medians, proportions, standard deviations, variances, correlation coefficients

- ensure that candidates know how to clearly explain what a confidence interval is. They can refer to the marking instructions notes for paper 1 question 1(d)(ii)
- ensure that candidates are equally competent at using both p-values and critical values. Candidates should understand that paper 1 'computer output' questions will rarely involve the use of critical values
- encourage candidates to check that they have responded to all of the command words in each question, especially when more than one task needs to be completed
- candidates should write either 'reject H_0' or 'do not reject H_0'. The phrases 'accept H_0' and 'accept H_1' should not be used
- candidates should phrase conclusions from all hypothesis tests to not be too definitive, or emphatic, ie instead of '... the population mean is greater than…' it is written less emphatically as '...evidence to suggest that the population mean may be greater than …'
- ensure that candidates are fully comfortable with the meaning of inequality signs and how they can change when calculating complementary events, and of their influence on the numbers involved when performing a continuity correction
- ensure that candidates know how a hypothesis test involving the difference in population means (for non-paired data) is different to a hypothesis test involving the population mean difference (of paired data)
- ensure that candidates know a precise definition of what the central limit theorem is, what its purpose is, when it is appropriate to use, and when it is not appropriate to use
- ensure that candidates know the difference in meaning between performing a hypothesis test on β and performing a hypothesis test on ρ, and also how the conclusions of each test are phrased differently

The use of graphing calculators in both the teaching of the course and in the course assessment is welcomed. However, the writing of 'calculator syntax' within the main lines of working is not acceptable. Instead, these annotations can be best included when written at the side, for example:

$\mathrm{P}(X = 52) = 0.0367$ from `binomPdf(104,0.55,52)`

and not

$\mathrm{P}(X = 52) =$ `binomPdf(104,0.55,52)` $= 0.0367$

Teachers and lecturers delivering the Advanced Higher Statistics course, and candidates undertaking the course, can consult the detailed marking instructions for the 2022 question papers on SQA's website. These illustrate the communication requirements in questions on, for example, confidence intervals, the central limit theorem and the general descriptions of various assumptions required for specific methods.

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.