

SQA Advanced Unit specification

General information

Unit title: Statistics for Science 1 (SCQF level 6)

Unit code: HT04 46

Superclass: RB

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Version: 01

Unit purpose

This Unit is designed to enable learners to utilise statistical techniques used in scientific analysis. Learners will develop an insight into where and when these statistical techniques should be employed, and will apply this knowledge in the context of scientific problems.

Outcomes

On successful completion of the Unit the learner will be able to:

- 1 Use and understand basic statistical concepts.
- 2 Use probability and probability distributions.

Credit points and level

1 SQA Credit at SCQF level 6: (8 SCQF credit points at SCQF level 6)

Recommended entry to the Unit

Entry to this Unit is at the discretion of the centre, but learners would normally be expected to hold appropriate mathematics Units at SCQF level 5. This could include National 5 *Mathematics*, or equivalent NQ level modules.

SQA Advanced Unit Specification

Core Skills

Achievement of this Unit gives automatic certification of the following Core Skills component:

Complete Core Skill	None
Core Skill component	Using Graphical Information at SCQF Level 6 Critical Thinking at SCQF Level 6

There are also opportunities to develop aspects of Core Skills which are highlighted in the Support Notes of this Unit specification.

Context for delivery

If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

The Assessment Support Pack (ASP) for this Unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website (<http://www.sqa.org.uk/sqa/46233.2769.html>).

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

Unit specification: Statement of standards

Unit title: Statistics for Science 1 (SQCF level 6)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the Knowledge and/or Skills section must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Use and understand basic statistical concepts.

Knowledge and/or Skills

- ◆ Understand these elementary statistical concepts:
 - Population
 - Sample
 - Random sampling
 - Measure of central tendency
 - Measure of spread
 - Difference between estimating population characteristics and true population characteristics
- ◆ Calculate these central tendencies and measures of dispersion for raw data:
 - mean
 - standard deviation
 - coefficient of variation
 - standard error
- ◆ Calculate correlation and perform linear regression:
 - Calculate regression parameters of linear functions (using, if available, calculators/computers)
 - Construct line graphs indicating line of best fit calculated above
 - Extrapolate values based on the above
- ◆ Construct and interpret appropriate statistical diagrams:
 - Select one of the following, as appropriate for the learners course of study:
 - Comparative boxplots
 - Histograms

SQA Advanced Unit Specification

Outcome 2

Use probability and probability distributions.

Knowledge and/or Skills

- ◆ Perform calculations involving probability distributions:
 - Normal distribution
 - Binomial distribution
 - Poisson distribution
- ◆ Select one of the following, as appropriate for the learners course of study:
 - Rules of probability in conjunction with Venn diagrams
 - Rules of probability in conjunction with probability trees

Evidence Requirements for this Unit

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills across all learning Outcomes by showing that they can:

Outcome 1

Use and understand basic statistical concepts.

- ◆ Provide/identify definitions of four of these six statistical concepts:
 - Population
 - Sample
 - Random sampling
 - Measure of central tendency
 - Measure of spread
 - Difference between estimating population characteristics and true population characteristics
- ◆ Calculate the central tendencies and measures of dispersion below for one set of raw data:
 - mean
 - standard deviation
 - coefficient of variation
 - standard error
- ◆ Calculate correlation and perform linear regression for one set of data with between 4 to 8 points:
 - Calculate the equation of the line of best fit, and correlation coefficients.
 - Construct the line graph indicating line of best fit calculated above.
 - Extrapolate values based on the equation of the line of best fit.
- ◆ Construct statistical diagrams appropriate to the course within which this Unit is embedded. These should be either:
 - at least two box plots on the same graph using appropriately contextualised data sets, compare and comment on the data sets.
 - group two sets of raw data into histograms using appropriately contextualised data sets, compare and comment on the data sets.

Outcome 2

Use probability and probability distributions

- ◆ Perform one calculation in an appropriate context utilising a probability tree OR one calculation involving the use of a Venn diagram.
- ◆ Perform one calculation for each of the following three probability distributions
 - Normal distribution
 - Binomial distribution
 - Poisson distribution

SQA Advanced Unit Specification

A calculator or computer package may be used in calculations for this Unit.

Assessment may be Outcome by Outcome, or with both Outcomes in a single holistic assessment.

The assessments should be under closed-book, supervised conditions.

Learners should not have information in advance about the content of the assessment.

Learners should be provided with a formulae sheet appropriate to the content of this Unit when undertaking an assessment (including data tables and definitions of probability distributions).

Unit Support Notes

Unit title: Statistics for Science 1 (SQCF level 6)

Unit Support Notes are offered as guidance and are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this Unit

This Unit is one of a suite of four Units in Mathematics and Statistics developed for SQA Advanced Qualifications across a range of Science disciplines. The four Units are:

- ◆ *Statistics for Science 1*
- ◆ *Statistics for Science 2*
- ◆ *Mathematics for Science 1*
- ◆ *Mathematics for Science 2*

This Unit leads on to the *Statistics for Science 2* Unit. In the development of this Unit a list of recommended topics has been identified. The use of this list of topics is strongly recommended to ensure continuity of teaching and learning and adequate preparation for the assessment of the Unit.

Consideration of this list of topics alongside the Assessment Support Pack for this Unit will provide clear indication of the standard expected.

Outcome 1

Use and Understand Basic Statistical concepts

- ◆ Explore the basic concepts of statistics. These should include populations and samples, random sampling, measures of central tendency (such as mean, median, and mode) and measures of spread (such as range, semi interquartile range, and standard deviation). The practical applications for each of the central measures should be considered.
- ◆ Calculate central tendencies and measures of dispersion for raw data. Calculate mean (average), standard deviation, coefficient of variation of raw data. The difference between population characteristics and characteristics of samples should be discussed (such as Bessel's correction). Explain the difference between standard deviation and Standard Error (standard error of the sample mean is an estimate of how far the sample mean is likely to be from the population mean, whereas the standard error of the sample mean is the degree to which individuals within the sample differ from the sample mean), and use the Standard Error ($\frac{S_n}{\sqrt{n}}$) to indicate how far the sample mean may vary from the population mean.
- ◆ Calculate the correlation coefficients for data expected to be linear. Examples from relevant scientific scenarios could be used. The line of best fit should be used to extrapolate values. Mention should be made of the reliability of extrapolation based on the correlation coefficient, and the domain of the experimental data. If time permits, and suitable software is available, non-linear regression might also be explored.

SQA Advanced Unit Specification

- ◆ The construction of box plots should be covered. Multiple boxplots should be drawn on the same diagram to allow comparison of data. Examples of scientific scenarios could be used to illustrate this.

OR

The construction of histograms, in particular using grouped frequency distributions. Examples of scientific scenarios could be used to illustrate this.

Computer packages or calculator functions should be used where possible throughout this Outcome, and computer simulations could be used for demonstration purposes

Outcome 2

Use probability and probability distributions.

- ◆ Revise basic probability.
- ◆ Study three distributions:
 - Normal distributions: calculate the number of normally distributed values meeting certain criteria (the number between values, or less than/ greater than values) using the normal distribution table.
 - Binomial distribution: Explore experiments with Outcomes that have a known probability of either success or failure.
 - Poisson distribution: Explore practical applications from science for which the Poisson distribution applies.

In each case a relevant scientific context from the learner's course should be selected.

- ◆ Depending on the course in which this Unit is embedded, select one of the following two topics to explore:
 - Illustrate rules of probability using Venn diagrams.
 - Illustrate rules of probability using probability trees.
 - Illustrate how probabilities multiply when two independent event occur together.
 - Expand this into a study of probability trees.
 - Illustrate probability trees using appropriate scientific examples.

Guidance on approaches to delivery of this Unit

This Unit provides core statistical principles and processes which underpin the studies from a number of SQA Advanced Qualifications across a range of scientific disciplines. It is recommended that the Unit be delivered towards the beginning of these awards.

Centres may deliver the Outcomes in any order they wish, but it is recommended that Outcome 1 is delivered first followed by Outcomes 2.

All teaching input should be supplemented by formative assessment in which learners are provided with opportunities to develop their knowledge, understanding and skills.

Computer software and computer algebra may be used to support learning.

Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. A recommended approach is the use of an examination question paper. The question paper could be composed of an appropriate balance of short answer, restricted response and structured questions.

SQA Advanced Unit Specification

Assessment may be Outcome by Outcome, in groups of Outcomes, or in a single holistic end of Unit assessment. The questions in the examination should not be grouped by Outcome or be labelled in terms of the Outcomes they relate to when a single end of Unit holistic examination is used.

The summative assessment of all three Outcomes — whether individually or at a single assessment event — should not exceed 2 hours. An appropriate threshold score may be set for the assessment of this Unit. A threshold score should be used for each assessment if Outcome level assessment is used. Note that if computers or scientific calculators are unavailable for the assessment of learning Outcome 1, then additional time may be allowed for assessment.

Assessment should be conducted under closed-book, controlled and invigilated conditions.

Learners should not have information in advance about the content of the assessment.

Learners should be provided with a formulae sheet appropriate to the content of this Unit when undertaking an assessment (including data tables and definitions of probability distributions).

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met.

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQAs qualifications is available at www.sqa.org.uk/e-assessment.

Opportunities for developing Core and other essential skills

This Unit has the Using Graphical Information component of Numeracy and Critical Thinking of Problem Solving embedded in it. This means that when candidates achieve the Unit, their Core Skills profile will also be updated to show they have achieved Using Graphical Information at SCQF level 6.

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence. Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

History of changes to Unit

Version	Description of change	Date

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SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our [Centre Feedback Form](#).

General information for learners

Unit title: Statistics for Science 1 (SQCF level 6)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for the further learning and employment.

The Statistics for Science 1 Unit is one of a suite of Mathematics and Statistics Units developed for SQA Advanced Certificates across a range of Science disciplines. These Units help develop the mathematical skills required for workplace roles and for more advanced studies in Science.

This Unit is designed to develop or consolidate the basic level of statistical skills required of learners across a range of Science disciplines. The Unit is at the level equivalent to Higher Mathematics.

In this unit, you will learn to:

- 1 Use and understand basic statistical concepts.
 - ◆ Understand these elementary statistical concepts:
 - Population
 - Sample
 - Random sampling
 - Measure of central tendency
 - Measure of spread
 - Difference between estimating population characteristics and true population characteristics.
 - ◆ Calculate these central tendencies and measures of dispersion for raw data:
 - mean
 - standard deviation
 - coefficient of variation
 - standard error
 - ◆ Calculate correlation and perform linear regression:
 - Calculate regression parameters of linear functions
 - Construct line graphs indicating line of best fit
 - Extrapolate values based on the above
 - ◆ Construct and interpret appropriate statistical diagrams
- 2 Use probability and probability distributions.
 - ◆ Perform calculations involving probability distributions:
 - Normal distribution
 - Binomial distribution
 - Poisson distribution
 - ◆ One of the following, as appropriate for your course of study:
 - Rules of probability in conjunction with Venn diagrams
 - Rules of probability in conjunction with probability trees

SQA Advanced Unit Specification

It is likely that Unit delivery will comprise of a significant teaching input from your lecturer. This will be supplemented by tutorial exercises which will allow you to develop the knowledge, understanding and skills to apply the statistical principles and processes covered in the Unit to a range of scientific problems.

Depending on which centre you attend, formal assessment may be conducted on an Outcome by Outcome basis or by one single assessment. Assessment will be conducted under closed-book, controlled and invigilated conditions.

Learners considering taking this Unit will normally be expected to have passed a course at National 5 in Mathematics or equivalent.