

SQA Advanced Unit Specification

General information

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

Unit code: HV6N 46

Superclass: RB

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Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to enable learners to utilise basic mathematical techniques used in scientific analysis. Learners will develop an insight into where and when these mathematical 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 Apply algebraic methods.
- 2 Solve problems using differential calculus.
- 3 Solve problems using integral calculus.

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.

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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

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: Mathematics for Science 1 (SCQF 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

Apply algebraic methods.

Knowledge and/or Skills

- ◆ Evaluate expressions involving powers, natural logarithms, common logarithms, exponentials, powers of 10, and trigonometrical functions
- ◆ Solve equations including quadratic equations and simultaneous equations (using algebraic methods)
- ◆ Change the subject of a formula involving powers, natural logarithms, common logarithms, exponentials, and powers of 10
- ◆ Solve problems involving ratio and proportion
- ◆ Calculations must include values in scientific or engineering notation

Outcome 2

Solve problems using differential calculus.

Knowledge and/or Skills

- ◆ Differentiate standard functions (polynomials, $(ax+b)^n$, \sin , \cos , \ln , e^{ax+b} , as well as sums and differences of these)
- ◆ Calculate rates of change for the above functions
- ◆ Find the second derivatives of functions
- ◆ Find the turning points of cubic equations

Outcome 3

Solve problems using integral calculus.

Knowledge and/or Skills

- ◆ Perform the indefinite integration of standard functions (polynomials, $(ax+b)^n$, \sin , \cos , $1/(ax+b)$, e^{ax+b} , as well as sums and differences of these)
- ◆ Perform the definite integration of the above functions
- ◆ Calculate the areas between curves (including the calculation of intercept points where appropriate)

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Evidence Requirements for this Unit

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

Outcome 1

Apply algebraic methods:

- ◆ Evaluate two equations, each involving a minimum of two of the following:
 - a power (x^n),
 - either \ln or \log_{10} ,
 - either e^x or power of 10^x
 - a trigonometrical function

Note that all four points must be tested.

Calculations must include values in scientific notation or engineering notation.

- ◆ Solve a problem including the solution of a quadratic equation.
- ◆ Solve a problem including a system of two simultaneous equations in two variables using algebraic methods.
- ◆ Change the subject of two formula, each involving at least one of:
 - a power (x^n)
 - either \ln or \log_{10}
 - an exponential or power of 10
 - a trigonometrical function
- ◆ Solve a problem involving ratio or proportion.

Outcome 2

Solve problems using differential calculus:

- ◆ Differentiate at least three of the following five types of expression:
 - polynomial
 - $(ax+b)^n$,
 - $\sin(ax+b)$ or $\cos(ax+b)$,
 - \ln ,
 - e^{ax+b}
- ◆ Evaluate one rate of change for one of the following functions:
 - polynomial
 - $(ax+b)^n$,
 - $\sin(ax+b)$ or $\cos(ax+b)$,
 - \ln ,
 - e^{ax+b}
- ◆ Find the locations and nature (using the second derivative method) of the stationary points on the graph of a cubic equation.

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Outcome 3

Solve problems using integral calculus:

- ◆ Obtain the indefinite integral for three of the following five types of expression, and evaluate definite integrals for the remaining two:
 - polynomial
 - $(ax+b)^n$,
 - $\sin(ax+b)$ or $\cos(ax+b)$,
 - $1/(ax+b)$
 - e^{ax+b}
- ◆ Calculate the area between two polynomial curves (including the calculation of at least one intercept point).

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

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

Formulae sheets containing the quadratic formula, standard derivatives and standard integrals may be provided where appropriate.

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.

Computer algebra, graphical calculators or programmable calculators should not be used in the assessment of this Unit.

Unit specification: Support notes

Unit title: Mathematics for Science 1 (SCQF 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 *Mathematics for Science 2* Unit.

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

Outcome 1

Apply algebraic methods.

- ◆ Revise basic algebraic methods.
- ◆ Evaluate algebraic expressions by substituting values. A range of functions should be explored, including expressions used in various scientific contexts.
- ◆ Solve problems using quadratic equations. Appropriate scientific contexts could be explored where appropriate to the course.
- ◆ Solve systems of linear equations using algebraic methods. The relationship between intersections of straight lines and the algebraic solution of simultaneous equations could be explored.
- ◆ Change the subject of various types of formulae. Contexts appropriate to the course should be explored where possible.
- ◆ Solve problems involving Ratios and Proportions. Contexts appropriate to the course could be included here.

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Outcome 2

Solve problems using differential calculus:

- ◆ Perform the Differentiation of standard functions, and functions commonly used in scientific contexts. Simple applications of the chain rule could be used as a strategy for differentiating functions like $f(ax+b)$, given the derivative of $f(x)$. Eg showing how to find the derivative of e^{ax+b} given the derivative of e^x , etc.
- ◆ The relationship between derivatives and gradients and rates of change should be considered.
- ◆ Find the locations and nature (using the second derivative method) of the stationary points on the graph of a cubic equation (incorporating the use of quadratic equation solutions). If time permits, the location and nature of the stationary points of non-polynomial equations could be explored.
- ◆ Scientific contexts should be explored where appropriate.

Outcome 3

Solve problems using integral calculus:

- ◆ Perform the Integration of standard functions, and functions commonly used in scientific contexts. The indefinite integral as an anti-derivative should be explored. Contexts should be selected from the course being studied.
- ◆ The relationship between definite integrals and areas under curves should be considered. Appropriate scientific contexts may be used here.
- ◆ Calculate the area between two curves. In the process, the important skill of finding an intersection point of two curves (the equality of functions) should be explored. Typically a quadratic and a linear function, or two quadratics, could be used here.

Guidance on approaches to delivery of this Unit

This Unit provides core mathematical principles and processes which underpin the studies undertaken in 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 and then Outcome 3.

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, computer algebra, and graphical calculators may be used to support learning (eg to confirm the solutions of mathematical problems), but it is strongly recommended that such learning resources are only used in a supportive capacity and not as the principal means of delivering Unit content.

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.

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.

Centres are reminded that submitting centre-devised assessments for prior verification 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, 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 SQA's 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 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: Mathematics for Science 1 (SCQF 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 *Mathematics for Science 1* Unit is one of a suite of mathematics 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 mathematical skills required of learners across a range of Science disciplines. The Unit is at the level of Higher Mathematics.

In this unit, you will learn to:

- 1 Apply algebraic methods.
 - ◆ Evaluate expressions involving powers, natural logarithms, common logarithms, exponentials, powers of 10, and trigonometrical functions
 - ◆ Solve quadratic equations
 - ◆ Solve simultaneous equations
 - ◆ Change the subject of a formula involving powers, natural logarithms, common logarithms, exponentials, and powers of 10
 - ◆ Solve problems involving ratio and proportion
- 2 Solve problems using differential calculus.
 - ◆ Differentiate standard functions (polynomials, $(ax + b)^n$, \sin , \cos , \ln , e^{ax+b} , as well as sums and differences of these)
 - ◆ Calculate rates of change
 - ◆ Find the second derivatives of functions
 - ◆ Find the turning points of cubic equations
- 3 Solve problems using integral calculus.
 - ◆ Perform the indefinite integration of standard functions (polynomials, $(ax + b)^n$, \sin , \cos , $1/(ax + b)$, e^{ax+b} , as well as sums and differences of these)
 - ◆ Perform the Definite Integration of the above functions
 - ◆ Calculate the areas between curves (including the calculation of intercept points where appropriate)

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 mathematic 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 Intermediate 2 or National 5 in Mathematics or equivalent.