



National Unit Specification

General information

Unit title: Mathematics for Science 3 (SCQF level 5)

Unit code: HP9X 45

Superclass: RB

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Source: Scottish Qualifications Authority

Version: 2

Unit purpose

The unit is intended for those learners who wish to gain the foundations of the Mathematics underpinning studies in all branches of science. The unit develops basic skills in calculation, algebra, graph reading and drawing.

Outcomes

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

- 1 Use algebraic methods
- 2 Use trigonometric functions
- 3 Perform calculations with vectors

Credit points and level

1 National Unit credit at SCQF level 5: (6 SCQF credit points at SCQF level 5)

Recommended entry to the unit

Candidates should hold the unit Mathematics for Science 3 (SCQF level 5) or an equivalent SCQF level 5 Mathematics qualification.

National Unit specification: General information (cont)

Unit title: Mathematics for Science 3 (SCQF level 5)

Core Skills

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

Complete Core Skill *Numeracy* at SCQF level 5

Core Skill component *Critical Thinking* at SCQF level 5

Context for delivery

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.

National Unit Specification: Statement of standards

Unit title: Mathematics for Science 3 (SCQF level 5)

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.

Outcome 1

Use algebraic methods.

Performance criteria

- (a) Multiply out double and triple brackets.
- (b) Complete the square (x^2).
- (c) Factorise quadratic equations (ax^2) and solve.
- (d) Solve quadratic equations using the quadratic formula.
- (e) Identify the position and nature of max/min of quadratic equation.
- (f) Solve simultaneous linear equations.
- (g) Add/subtract algebraic fractions.

Outcome 2

Use trigonometric functions.

Performance criteria

- (a) Sketch and identify equations for basic trigonometric graphs.
- (b) Solve equations of basic trigonometric functions.
- (c) Solve problems using the sine rule.
- (d) Solve problems using the cosine rule.

Outcome 3

Perform calculations with vectors.

Performance criteria

- (a) Understand vector and scalar definitions.
- (b) Perform 2D and 3D vector addition, subtraction and scalar multiplication.
- (c) Add and subtract 2D vectors using graphical methods.
- (d) Convert vectors from polar to rectangular form and vice versa using calculator (degrees).
- (e) Calculate the magnitude of a 3D vector.

National Unit Specification: Statement of standards (cont)

Unit title: Mathematics for Science 3 (SCQF level 5)

Evidence requirements for this unit

Evidence is required to demonstrate that learners have achieved all outcomes and performance criteria.

Assessment may be carried out:

- ◆ Outcome by outcome
- ◆ Two or more outcomes together

Evidence should be produced under closed-book, supervised conditions.

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

A formula sheet containing the quadratic formula may be provided.

Scientific calculators may be used, but computer algebra packages, graphical calculators or programmable calculators should not be used.

Sufficient working must be shown to demonstrate the method of solution.

Where reassessment is needed, an alternative instrument of assessment must be used.

Total Assessment time should not exceed 2 hours.

Outcome 1

Use algebraic methods:

- ◆ Multiply out double and triple brackets:
 - Perform at least one calculation of the form $(ax+b)(cx^2+dc+e)$.
 - Perform at least one calculation of the form $(ax+b)(cx+d)(ex+f)$.
- ◆ Complete the square (x^2):
 - Complete the square of a problem of the form x^2+bx+c , with a, b, c positive or negative.
- ◆ Factorise quadratic equations (ax^2) and solve:
 - Solve at least one problem of the form $ax^2+bx+c=0$ using factorisation, with a, b, c positive or negative.
 - Solve at least one problem of the form $ax^2+bx=0$ using factorisation, with a, b positive or negative.
- ◆ Solve quadratic equations using the quadratic formula:
 - Solve at least one problem of the form $ax^2+bx+c=0$ using the quadratic formula, with a, b, c positive or negative.
- ◆ Identify the position and nature of max/min of quadratic equation:
 - Identify the position and nature of the turning point (x, y) of a quadratic formula.
- ◆ Solve simultaneous linear equations:
 - Formulate at least one equation of a pair of simultaneous equations from a given context.
 - Solve at least one system of simultaneous equations.

National Unit Specification: Statement of standards (cont)

Unit title: Mathematics for Science 3 (SCQF level 5)

- ◆ Add/subtract algebraic fractions (all coefficients may be positive or negative):
 - Add or subtract one equation of the form
$$\frac{ax+b}{c} \pm \frac{dx+e}{f} \quad c \neq f$$
 - Add or subtract one equation of the form
$$\frac{a}{bx+d} \pm \frac{e}{fx+g} \quad bx+d \neq fx+g$$

Outcome 2

Use trigonometric functions.

- ◆ Sketch and identify equations for basic trigonometric graphs:
 - Sketch at least one graph and identify at least one equation:
 - one must be of the form $y=A.\sin(ax)$ or $y=A.\cos(ax)$,
 - the other must be of the form $y=A.\sin(x+b)$ or $y=A.\cos(x+b)$, where b may be positive or negative.
- ◆ Solve equations of basic trigonometric functions:
 - Solve at least one equation of the form $A.\sin(ax)=k$ or $A.\cos(ax)=k$, $a \neq 1$.
 - Solve at least one equation of the form $A.\sin(x+b)=k$ or $A.\cos(x+b)=k$, where b may be positive or negative.
 - One equation must use \sin , the other \cos .
 - One equation must use $k < 0$, the other $k > 0$.
- ◆ Solve problems using the sine rule:
 - Solve one sine rule problem for either a side or an angle.
- ◆ Solve problems using the cosine rule:
 - Solve at least one cosine rule problem for either a side or an angle.
 - If the sine rule problem was to solve an angle, solve for a side, and vice versa.

Outcome 3

Perform calculations with vectors.

- ◆ Understand vector and scalar definitions:
 - Identify vectors and scalars from a short list of options.
- ◆ Perform 2D and 3D vector addition, subtraction and scalar multiplication:
 - Perform at least one calculation including scalar multiplication and addition or subtraction of 2D vectors.
 - Perform at least one calculation including scalar multiplication and addition or subtraction of 3D vectors.
- ◆ Convert vectors from polar to rectangular form and vice versa using calculator (degrees):
 - Convert one vector from rectangular to polar form, and one from polar to rectangular form.
 - Built in calculator functionality for conversion may be used.
- ◆ Add and subtract 2D vectors using graphical methods:
 - Add or subtract two vectors in rectangular form using graphical methods.
 - Questions may state the scale, and graph paper may be used.
- ◆ Calculate the magnitude of a 3D vector.



National Unit Support Notes

Unit title: Mathematics for Science 3 (SCQF level 5)

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 part of the National Certificate Group Awards in Applied Science, but can also be a free-standing unit. This unit aims to build on and extend the learner's mathematical knowledge and skills.

It is envisaged that the content of this unit is delivered in scientific contexts appropriate to the learner, whether as a unit of the group award or as a free-standing unit.

Applying the mathematical skills of the unit in meaningful scientific scenarios will enable the learner to appreciate that those skills are essential tools for scientific analysis.

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 algebraic methods.

- ◆ Multiply out double and triple brackets:
 - Multiply out brackets more complicated than those in the previous unit, like $(ax+b)(cx^2+dc+e)$ and $(ax+b)(cx+d)(ex+f)$. This includes the skill of collection like terms.
- ◆ Complete the square (x^2):
 - Complete the square of quadratics. If time allows the relationship between the quadratic formula and completing square could be examined.
- ◆ Factorise quadratic equations (ax^2) and solve:
 - Solve quadratic equations using factorisation. Look at general cases, as well as cases where the coefficient of $x^2 \neq 1$, and cases where the zero order coefficient is zero.
- ◆ Solve quadratic equations using the quadratic formula:
 - Solve quadratic equations using the quadratic formula.
- ◆ Identify the position and nature of max/min of quadratic equation:
 - Identify the turning points of quadratic equations. The x value could be found using $x = \frac{-b}{2a}$ or as the midpoint of the solutions. The y value should be found by substituting x into the quadratic equation.

National Unit Support Notes (cont)

Unit title: Mathematics for Science 3 (SCQF level 5)

- ◆ Solve simultaneous linear equations:
 - Learn how to formulate systems of quadratic equations from context, and then solve them by elimination methods. If time permits, substitution methods could also be explored.
- ◆ Add/subtract algebraic fractions:
 - Add or subtract algebraic fractions, including cases of the form $\frac{ax+b}{x} \pm \frac{dx+e}{f}$ and $\frac{a}{bx+c} \pm \frac{d}{ex+f}$.

Outcome 2

Use trigonometric functions.

- ◆ Sketch and identify equations for basic trigonometric graphs:
 - Examine how amplitude, frequency and phase change as the variables in a trigonometric functions of the forms $y=A.\sin(ax)$ or $y=A.\cos(ax)$, and $y=A.\sin(x+b)$ or $y=A.\cos(x+b)$.
 - If time allows, show how to state equations from sketches of the functions of the form $y=A.\sin(ax+b)$ and $y=A.\cos(ax+b)$.
- ◆ Solve Equations of form $y=A.\sin(ax+b)$, $y=A.\cos(ax+b)$:
 - Solve equations of the form $A.\sin(ax)=k$ or $A.\cos(ax)=k$, $a \neq 1$.
 - Solve equations of the form $A.\sin(x+b)=k$ or $A.\cos(x+b)=k$.
 - If time allows, show how to solve trigonometric equations of the form $A.\sin(ax+b)=k$ or $A.\cos(ax+b)=k$ with both positive and negative values of k , $a \neq 1$.
- ◆ Sine Rule:
 - Solve problems using the sine rule looking for both unknown angles and unknown sides.
- ◆ Cosine Rule:
 - Solve problems using the cosine rule looking for both unknown angles and unknown sides.

Outcome 3

Perform calculations with vectors.

- ◆ Understand vector and scalar definitions:
 - Examine the vectors and scalars from different contexts, discussing why they fall into each category (for examples, discuss why weight is a vector, yet mass is a scalar).
- ◆ Perform 2D and 3D vector addition, subtraction and scalar multiplication:
 - Examine vector addition, subtraction, and scalar multiplication and combinations of these operations in rectangular form.
- ◆ Convert vectors from polar to rectangular form and vice versa using calculator (degrees):
 - Convert 2-D vectors between polar and rectangular form.

National Unit Support Notes (cont)

Unit title: Mathematics for Science 3 (SCQF level 5)

- ◆ Add and subtract 2D vectors using graphical methods:
 - Use drawings to add vectors in rectangular form. Results could be compared to algebraic addition and subtraction.
 - If time allows, consider adding and subtracting vectors in polar form using graphical methods.
- ◆ Calculate the magnitude of a 3D vector:
 - Use $\sqrt{a^2+b^2+c^2}$ for magnitude.

Guidance on approaches to delivery of this unit

This unit provides skills, techniques and processes underpinning studies undertaken in Science, and as such, opportunities should be taken to contextualise delivery where possible.

Centres may deliver the outcomes in any order they wish.

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).

Guidance on approaches to assessment of this unit

Evidence may be generated using different types of assessment. The following are suggestions only and there may be other methods that would be more suitable to learners.

It is possible to assess learners either on an outcome by outcome basis or by combining some or all outcomes into one assessment event. Centres may assess the outcomes in any order they wish.

The assessment papers could be composed of an appropriate balance of short answer, restricted response and structured questions. Most parts of this unit lend themselves to assessment using straightforward scientific contexts, and questions should be contextualised where appropriate. Some part of the unit, however, such as those dealing with basic algebraic skills might be better assessed without context.

Care should be taken to avoid excessively elaborate contexts or language.

National Unit Support Notes (cont)

Unit title: Mathematics for Science 3 (SCQF level 5)

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 SQA's qualifications is available at www.sqa.org.uk/e-assessment.

Opportunities for developing Core and other essential skills

This unit has the Core Skill of *Numeracy* embedded in it, so when learners achieve this unit their Core Skills profile will be updated to show that they have achieved *Numeracy* at SCQF Level 5

This unit has the *Critical Thinking* component of *Problem Solving* embedded in it. This means that when learners achieve the unit, their Core Skills profile will also be updated to show they have achieved *Critical Thinking* at SCQF level 5.

History of changes to unit

| Version | Description of change | Date |
|---------|---|------------|
| 2 | Core Skill Numeracy at SCQF level 5 embedded. Core Skill Component Critical Thinking at SCQF level 5 embedded. | 12/09/2017 |
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General information for learners

Unit title: Mathematics for Science 3 (SCQF level 5)

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 further learning and employment.

The unit is intended to help you consolidate and develop your knowledge of the mathematics underpinning studies in science, and is designed to lead on to the mathematics units in the Higher National framework for Applied Sciences and related disciplines. The unit develops skills in algebra, trigonometry and vectors.

The unit covers the following topics:

- ◆ Use algebraic methods:
 - Algebra is the essential language of scientific analysis. In this section you will learn some further algebraic methods including dealing with algebraic fractions, brackets, factorisation, solving quadratic equations and simultaneous equations.

- ◆ Use trigonometric functions:
 - In this section you will learn how to sketch and interpret wave functions based on trigonometric functions. You will also learn how to use trigonometric functions to identify unknown side lengths and angles in non-right angles triangles.

- ◆ Perform calculations with vectors:
 - In this section, you will learn how to convert vectors between different representations, perform calculations with Vectors in both 2D and 3D as well as calculate magnitudes.

Assessment

The assessments for this unit may be distributed though the course, or at the end of the unit, and will be closed-book (that is, you cannot take notes into the assessment). You will be allowed to use a scientific calculator, but not an advanced programmable or graphing calculator. Total assessment time is limited to 2 hours.

Core Skills

This unit has the Core Skill of *Numeracy* embedded in it, so when you achieve this unit your Core Skills profile will be updated to show that you have achieved *Numeracy* at SCQF level 5.

This unit also has the *Critical Thinking* component of *Problem Solving* embedded in it. This means that when you achieve the unit, your Core Skills profile will also be updated to show you have achieved *Critical Thinking* at SCQF level 5.