National Unit specification

General information

Unit title: Construction Calculations (SCQF level 5)

Unit code: H66G 45

Superclass: RB

Publication date: January 2014

Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to provide learners with underpinning mathematical skills. Although mathematical skills are assessed, it should be emphasised that they are being used in practical construction applications and contexts. Mathematics is the tool; construction is the context.

The learners will learn how to use mathematical concepts and apply them to the topics within the area of the Built Environment such as construction details and land surveying.

This Unit is suitable for learners who aspire to a career in the construction industry or related fields as a technician or technologist.

Outcomes

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

1 Apply/use of Pythagoras' theorem and trigonometry in right-angled triangles and sine, cosine and tangent rules to solve construction problems.
2 Use standard formulae to calculate areas and volumes in construction.
3 Construct graphs to show construction data.
4 Transpose formulae used in construction.

National Unit specification: General information (cont)

Unit title: Construction Calculations (SCQF level 5)

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

While entry is at the discretion of the centre, learners would normally be expected to have attained the following, or equivalent:

- Standard Grade Mathematics at General level
- Intermediate 2 or National 4/5 in Mathematics

Core Skills

Achievement of this Unit gives automatic certification of the following:

Complete Core Skill	Numeracy at SCQF level 6
Core Skill component	None

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

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 instrument of 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: Construction Calculations (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

Apply/use of Pythagoras' theorem and trigonometry in right-angled triangles and sine, cosine and tangent rules to solve construction problems.

Performance Criteria

(a) Apply Pythagoras' theorem to applications used in the construction industry.
(b) Solve problems using sine, cosine and tangent relating to applications in the construction industry.
(c) Calculate unknown length of sides and angles in a triangle using the sine rule and cosine rule.

Outcome 2

Use standard formulae to calculate areas and volumes in construction.

Performance Criteria

(a) Use Standard formulae to calculate areas in construction.
(b) Solve calculations of volumes using standard formulae relating to applications in the construction industry.

Outcome 3

Construct graphs to show construction data.

Performance Criteria

(a) Construct best-fit straight-line graphs from accumulated data.
(b) Extract and interpolate information from straight-line graphs.
(c) Select an appropriate form of graph for the representation of given tabulated data.
(d) Plot graphs from given tables of data.

Outcome 4

Transpose formulae used in construction.

Performance Criteria

(a) Extract information from standard tables.
(b) Solve problems by applying consistent Units and powers.
(c) Apply appropriate Units to construction formulae.
(d) Solve problems by transposing formulae, substituting numerical values and providing the appropriate Units to the answers.

National Unit specification: Statement of standards

Unit title: Construction Calculations (SCQF level 5)

Evidence Requirements for this Unit

Evidence is required to demonstrate that learners have achieved all Outcomes and Performance Criteria.

Written and/or recorded oral evidence is required to demonstrate that the learner has achieved this Unit to the standard specified in the Outcomes and Performance Criteria. The evidence for this Unit should be obtained under controlled**,** supervised conditions.

Evidence will be gathered at appropriate points throughout the delivery of the Unit.

Assessment must be manageable and practicable for centres.

Outcome 1 Application of Pythagoras' Theorem to basic construction activities
Outcome 2 Calculation of areas and volumes
Outcome 3 Construct graphs from given data to illustrate construction activities or events
Outcome 4 Extract data, apply to formulae and manipulate to determine performance materials or structures

Not all questions need be of equal weighting.

National Unit Support Notes

Unit title: Construction Calculations (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 intended to introduce the learner to the mathematical skills required by technicians following the NC Built Environment and Civil Engineering programmes. The Unit should allow the learner to develop their skills and transfer them into a construction context. Emphasis should be placed on the rounding of numbers in answers, significant figures and the application of Units.

Outcome 1 (10 hours) requires the learner to recognise the application of Pythagoras' theorem and the use of sine, cosine and tangent in right-angled triangles; and the application of sine rule and cosine rule to solve practical construction problems. Possible applications could include:

- given the horizontal and vertical dimensions, determine the pitch of a roof.
- given the gradient of a pipe and its horizontal distance, determine the vertical difference in height for the length of the pipe.
- given the polar coordinate of a survey line, determine the partial easting and the partial northing of the line.
- given the partial easting and the partial northing of a survey point determine the horizontal distance and angle to the point relative to a survey baseline.
- given the coordinates of two survey points, determine the horizontal length between these points and the horizontal direction relative to Ordnance Survey Grid North.
- given reference information for a construction site baseline, determine the coordinates of additional stations required on site.

This list should be taken as indicative and is not exhaustive.

Outcome 2 (12 hours) requires the learner to recognise the need for consistency of Units in a formula and is an introduction to numerical analysis. The learner should be able to convert Units for the calculation of areas and volumes.

National Unit Support Notes (cont)

Unit title: Construction Calculations (SCQF level 5)

Possible applications could include:

- extract dimensions from general arrangement plans and calculate regular areas and volumes of construction materials required.
- calculate the area of parcels of land. These should be restricted to regular areas using standard formula and the result in m^2 or hectares.
- calculate the volume of earthwork material to be moved, or taken off-site, to a given profile. This could include calculation of areas from levelling (height) information, eg drainage trenches.

This list should be taken as indicative and is not exhaustive.

Outcome 3 (8 hours) requires the learner to recognise the need for graphs in the construction industry and the presentation of data to non-technical people.

Possible applications could include:

- using data gained from previous Outcomes.
- given data on the construction sectors in the construction industry, the learner produces pie-charts to indicate the percentage of these sectors, or histograms to show data frequency occurring within certain ranges or intervals.
- given the breakdown percentage costs for the construction of domestic low-rise houses the learner presents the information graphically.
- given the cost of building domestic properties over a period of time, the learner plots the points, constructs the 'best fit' straight line and obtains the future cost of building such Units.
- given the width of trees at various stages, the learner plots the points, constructs the 'best fit' straight line and obtains the width at maturity.

This list should be taken as indicative and is not exhaustive.

Outcome 4 (10 hours) requires the learner to recognise the need for consistency of Units in a formula and is an introduction to numerical analysis. The learner should be able to extract information from standard tables, evaluate formula, and apply correct Units to the answers.

Possible applications could include:

- extract data from the Structural Steel Section tables in mm, cm^2, cm^3 and cm^4 as appropriate, apply the data to formula requiring the output Units to be kN, kNm, kN/m^2 (kPa) or N/mm^2 (MPa), etc.
- calculate the area, elastic modulus, plastic modulus, second moment of area about the centroid of regular shapes, use the calculated values to determine magnitudes of loads, moments, deflections, etc.
- transpose the general bending expression, standard formulae for determining bending moments, deflection formulae, etc. Substitute values and state answers in appropriate Units.

This list should be taken as indicative and is not exhaustive.

National Unit Support Notes (cont)

Unit title: Construction Calculations (SCQF level 5)

Problem solving, numeracy and communication are fundamental parts of the construction process. By learning the principles in this Unit, learners will be able to transfer these skills to obtain a deeper understanding of these principles as they progress to further studies or employment. The examples used in this Unit are everyday features of the construction process and learners should be familiar with these principles to pursue a career in the construction industry. Learners that can solve similar problems will be a valuable member of a construction team.

Guidance on approaches to delivery of this Unit

It is important that the delivery of this Unit is related to practical construction problems, which the learner will meet in subsequent Units such as DW5H 34 *Site Surveying A*. As part of the course, learners should be told the relevance of the problems undertaken and in which Units, they will be expected to use the transferable skills learned in this Unit. The main aim of this Unit should be to enable learners to relate the principles learned to other Units and to help them gain an appreciation of the need for mathematical skills in the construction industry through practical examples. Every opportunity should be taken to revise and consolidate prior knowledge. The correct use of scientific calculators should be demonstrated and encouraged where appropriate.

Outcome 1

The mathematical concepts of right-angled triangles should be related to the areas of construction and this may be introduced by tasks such as:

- determine the hypotenuse of right-angled triangles using the horizontal and vertical components.
- determine the horizontal component of right-angled triangles using the hypotenuse and vertical component.
- determine the vertical component of right-angled triangles using the hypotenuse and horizontal component.

The use of sine, cosine and tangent in right-angled triangles to determine construction measurements can be introduced by the:

- relationship of hypotenuse and right angle.
- relationship of sine with opposite and hypotenuse.
- relationship of cosine with adjacent and hypotenuse.
- relationship of tangent with opposite and adjacent.

Eastings and Northings as used in land surveying are an application of Cartesian Coordinates and as such can be used to find lengths, angles or co-ordinates of points using either the sine or cosine rules.

The sine rule and cosine rule are used every day in the calculation of angles and distances. This Unit gives the learner the ability to become familiar with these formulæ, which are later used frequently in their studies with regard to the calculation of curves for their co-ordinates.

National Unit Support Notes (cont)

Unit title: Construction Calculations (SCQF level 5)

Outcome 2

Typical formulae that may be introduced to the learners may include:

- areas of regular shapes such as squares = L x L, rectangles = L x B, rhombus = L x H, parallelogram = L x H, trapezoid = $(L_1 + L_2)/2$ x H, common triangles = ½BH, equilateral triangles = $L^2/4 \times \sqrt{3}$, isosceles triangle = ½common long side^2 x sine α, right-angled triangles = ½LH and circles = πR^2
- areas of multiples of regular shapes such as parcels of land using a combination of above methods.
- areas of parts of regular shapes such as segments and sectors of circles.
- volumes of regular shapes such as cubes = L x L x L, cuboids = L x B x H, pyramids = ⅓Base^{2}H, cylinder = $\pi R^2 H$, spheres = $^4/_3\pi R^3$ and hemispheres = $^2/_3\pi R^3$
- volumes of regular shapes such as hollow cylinders = $\pi H(R^2 - r^2)$, hollow spheres = $^4/_3\pi(R^3 - r^3)$ and hollow hemispheres = $^2/_3\pi(R^3 - r^3)$
- volumes of regular grid shapes such as earthworks to be excavated using Rectangular Base Method.

Learners should evaluate formulae. This may involve transposition of the formula, extracting information from standard tables and applying consistent Units.

Outcome 3

This Outcome looks at the use of graphs in the construction industry:

Pie charts, histograms and ogive curves used construction sectors, construction elements to show the percentage and breakdown of costs in construction such as substructure, superstructure and services costs.

The use of best-fit straight line graphs are used to predict future cost of construction and tree growth on a site in relation to construction foundations.

Outcome 4

Typical formulae that may be introduced to the learners may include:

- the bending expression in it variety of forms, ie f=My/I, f=M/Z, R=EI/M, etc.
- standard deflection formulae, $\Delta = 5wL^4/384EI$, $\Delta = WL^3/48EI$, $\Delta = wL^4/8EI$, $\Delta = WL^3/3EI$
- Second moment of area, $I = bd^3/12$, $I = \pi D4/64$
- soil properties using $\rho = M/V$ in its various forms.

Learners should evaluate formulae this may involve transposition of the formula, extracting information from standard tables and applying consistent Units.

National Unit Support Notes (cont)

Unit title: Construction Calculations (SCQF level 5)

Guidance on approaches to assessment of this Unit

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

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Achievement of this Unit requires the Performance Criteria for each Outcome to be met. A learner who does not initially achieve the specified standard can have a further opportunity, attempting only the Outcome(s) not previously achieved.

The evidence for this Unit should be obtained under controlled**,** supervised conditions. The assessment will be closed-book and should last no more than 2 hours in total. A formula sheet will be provided.

Typical forms of assessment may involve:

Outcome 1

Learners may be given tasks which require the use of Pythagoras' Theorem with the use of sine, cosine or tangent, and either the use of sine rule or cosine rule to solve construction problems.

Pythagoras' Theorem

The learners may be given the horizontal and vertical dimensions from a roof system and are required to determine the hypotenuse (rafter) length and roof pitch.

Alternatively, the learners could be given information from a topographical survey involving partial easting(s) and partial northing(s) and hence calculate the length of a line and its angle from a survey reference point.

Sine/Cosine rules

The learners could be given information relating to survey stations and using either the sine rule or cosine rule determine the distance or angle required within a local survey control system.

Outcome 2

The learners may be given a standard formula, used in construction; to calculate regular areas. The formula used must involve terms with a variety of Units. For example in calculating the area of a gable wall, roof area or wall with opening where the Units are given in mm and the area to be expressed in m^2.

National Unit Support Notes (cont)

Unit title: Construction Calculations (SCQF level 5)

The learners may be given a standard formula, used in construction to calculate regular volumes. The formula used must involve terms with a variety of Units. For example in calculating the volume of a drainage trench, cylinders or cold water storage tanks where the Units are given in mm and the area to be expressed in m^3.

Outcome 3

The learner may be given two sets of data from which to create graphs. One set of data will involve the construction of a pie chart, histogram or ogive (cumulative frequency = running total) curve. The other set will require the learners to construct a 'best-fit' graph and extraction of a value.

Outcome 4

The learners may be given a standard formula used in construction, the formula must be transposed and data required in its use is extracted from standard tables before solving an unknown. The formula used must involve terms with a variety of Units. For example, using the standard formula for the maximum deflection of a simply supported steel beam carrying a uniformly distributed load over the entire span $\Delta = 5wL^4/384EI$ requires the learner to evaluate the formula when the Units expected for the individual terms are in mm, kN/m, N/mm^2 and cm^4 hence requiring the learner to apply consistent Units to the formula.

This Outcome can be assessed either by a single task/question or by two task/questions. One task can assess the transposition of a formula, and its subsequent solution. The other can be by the extraction of data from standard tables and, by the inclusion into a formula for solution. An alternative is to include all elements in one task.

The Assessment Support Pack (ASP) for this Unit provides sample assessment material. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard.

There may be opportunities for Accreditation of Prior Learning (APL) for learners who have undertaken the previous version of this Unit F3JL 12 *Construction Calculations*. This is at the discretion of delivering centres.

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment that is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres that 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**.

National Unit Support Notes (cont)

Unit title: Construction Calculations (SCQF level 5)

Opportunities for developing Core and other essential skills

In this Unit learners will be:

- completing calculations.
- completing sketches.

These offer opportunities to develop aspects of the Core Skills of:

- *Numeracy*
- *Problem Solving*
- *Communication*

The development of these skills is essential for a learner, as a potential employee, in their future employment by an employer. The learner that learns how to communicate, a particular problem that has to be resolved with, the correct solution numerically would be a valuable asset to any employer.

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

History of changes to Unit

Version	Description of change	Date

General information for learners

Unit title: Construction Calculations (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 construction industry uses many different types of calculations to produce the end result that may be a house, a shopping centre, offices, a bridge, roads, etc. The calculations are used for many different purposes such as the sizes and areas of plots of land, amount of materials required and the cost of these materials.

Construction, in general, uses regular shapes that you should already be familiar with and this Unit is designed to develop those skills. These calculations are the basis of additional methods available that you may be involved in at later stages of your education or in employment.

You should be able to calculate simple trigonometry examples using sine, cosine and tangent. Additional methods such as the sine rule and cosine rule will be studied and used where you will determine distances and direction that have an important role in the first steps of constructing a house or bridge. The need for these Structures to be constructed in the correct place and can be achieved by the use of trigonometry and associated rules.

You should be able to calculate the area and volume of simple shapes. There are many regular shapes, which are used to reflect the natural shape of construction, and the land these constructions are built upon. You will use these methods to determine, for example, whether a house of a certain size can fit into the available plot size.

You will become familiar with plotting rectangular graphs using the x and y axis. The Unit will give you the opportunity to plot pie charts to show percentages from a list of data. This method is sometimes a better format for people to relate to. You will use lines of best fit in graphs to forecast what will happen for example to cost and sizes in the future.

You should be able to transpose formulæ for calculating particular properties in the materials used in construction and look up standard tables of materials.

The assessment for this Unit may take the form of one closed-book assessment based on the above information consisting of a series of questions/tasks. The assessment should last no longer than 2 hours. A formula sheet will be supplied
.
There are opportunities to develop the Core Skills of *Communication, Numeracy, Problem Solving,* in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

This Unit will give you the skills and knowledge that are required to develop your learning and education for further studies within the construction industry or to take up employment.