SQA Advanced Unit Specification

General information for centres

Unit title: Mathematics for Computing 1

Unit code: HP1H 47

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Unit purpose

This unit is designed to allow candidates to acquire the fundamental mathematical knowledge required to apply computing techniques to problem situations effectively. Candidates will be able to create a mathematical model or express a problem mathematically. It is primarily intended for candidates who will specialise in programming or candidates who require a deeper understanding of computer operation at a basic hardware level.

On completion of the unit the candidate should be able to:

1. demonstrate an understanding of scientific notation and manipulate numbers in scientific notation
2. demonstrate an understanding of co-ordinate systems and vectors, and apply linear transformations
3. demonstrate a knowledge of simple functions and the ability to perform basic algebraic operations
4. demonstrate the application of Boolean algebra to problem situations

Credit points and level

1 SQA Credit at level 7: (8 SCQF credit points at SCQF level 7*).

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from National 1 to Doctorates.*

Recommended prior knowledge and skills

Access to this unit will be at the discretion of the centre. The unit has no mandatory prerequisites, however it is recommended that candidates have numeracy skills at National 5 level. This may be demonstrated by the achievement of the Numeracy unit at National 5 level.

Core skills

This unit gives automatic certification of the following core skills elements:

- *Using Number* at SCQF level 6
- *Using Graphical Information* at SCQF level 5

Context for delivery

This unit is included in the framework of a number of SQA Advanced Certificate and SQA Advanced Diploma group awards. It is recommended that it is taught and assessed within the context of the particular group award to which it contributes.

General information for centres

Assessment

The unit may be assessed by a single instrument of assessment which would require candidates to apply a range of mathematical techniques to a single problem situation (or different aspects of the same problem). The assessment may be extended to cover the assessment requirement of other units within the SQA Advanced Computing frameworks, eg writing a program to implement the mathematical solution to the problem. The assessment will not generally be presented in a supervised situation.

It is also possible to present four smaller supervised assessment events of a maximum of 45 minutes duration (one for each outcome) covering a particular aspect of the outcome to which it applies. In all cases, the assessment instruments should be in the context of computing and presented as a problem situation.

Any single outcome assessed in combination with another unit (or units) is subject to the same conditions although the time limit may be extended.

Unit specification: statement of standards

Unit title: Mathematics for Computing 1

The sections of the unit stating the outcomes, knowledge and/or skills, and evidence requirements are mandatory.

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. Candidates 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

Demonstrate an understanding of scientific notation and manipulate numbers in scientific notation

Knowledge and/or skills

- ♦ The difference between real numbers and integers
- ♦ Power notation and multiplication and division of powers
- ♦ The ability to express numbers in scientific notation
- ♦ The ability to perform arithmetic on numbers in scientific notation
- ♦ The need to round real numbers and estimate the resulting error
- ♦ How real numbers and integers are represented in computer memory

Evidence requirements

Evidence for the knowledge and/or skills in this outcome will be provided on a sample basis.

If a single holistic unit assessment task is adopted, then at least 12 of the 24 total unit knowledge/skill items must be covered by the assessment with a minimum of three items from each of the four outcomes which must always include Item 6 from Outcome 1.

For a single holistic unit assessment, the candidate will be presented with a single problem one week prior to the submission date (or earlier if assessment is combined with other unit assessments). It is possible to offer a choice of several problems with the candidate selecting only one. The assessment must be varied regularly. The assessment will refer to a practical situation relevant to an aspect of computing. The candidate will submit the response as a short report. Guidance on the format of the report and a minimum list of contents must be provided along with the assessment to ensure that the evidence requirements are met.

Alternatively, if the outcome is assessed with one dedicated assessment, a minimum of three of the knowledge/skills items – which must always include Item 6 from this outcome – must be tested. In this case, the assessment will be a single problem stated within a practical context presented in a supervised situation. **Non-scientific** calculators, textbooks and notes may be used by the candidate during the assessment, but s/he should have no pre-knowledge of the assessment. The assessment must be varied on each assessment occasion.

Where an item is sampled, a candidate's response can be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ♦ distinguish between real numbers and integers demonstrated by correctly choosing data types in a minimum of four problem situations
- ♦ identify the correct index for a series of numbers that are powers of 10 (a minimum of three correct responses including positive, negative and 0 indices); correctly multiply and divide number presented in power notation (a minimum of three correct responses. including a number with a positive index divided by a number with a negative index)
- ♦ express positive numbers, negative numbers, large numbers and small fractions in scientific notation (a minimum of four correct responses)
- ♦ add, subtract, multiply and divide two numbers expressed in scientific notation (one correct response for each of the four operations)
- ♦ state the absolute and relative error associated with real numbers and be able to round a number to a stated number of significant figures or decimal places (one correct response to demonstrate each of the four operations)
- ♦ state the range of integers that can be expressed with 1, 2 and 4 bytes of memory; explain how floating-point numbers are stored (short description of each data type describing the range of numbers that can be expressed)

Whichever assessment method is adopted, the candidate should attain a minimum of 60% of the available marks for each outcome to reach the standard required for a pass.

Assessment guidelines
If the preferred assessment method is four individual assessments, one of these must test this outcome. In this case it is recommended that the assessment should be completed in about 45 minutes.

An important objective in presenting this material is to ensure candidates have a good understanding of data types for programming and database design. The assessment may test this. A secondary objective is that candidates should be able to understand terms such as ns and MHz. This is useful for candidates who specialise in hardware and therefore a calculation involving a reference to computer hardware operation might be an alternative assessment topic.

Outcome 2

Demonstrate an understanding of co-ordinate systems and vectors and apply linear transformations

Knowledge and/or skills

- ♦ Co-ordinate systems in two dimensions, particularly Cartesian co-ordinates
- ♦ The ability to represent simple shapes by finding the co-ordinates of the vertices
- ♦ The concept of a vector
- ♦ The polar representation of a vector
- ♦ The ability to offset and scale shapes described by co-ordinates
- ♦ The co-ordinate system used in programming output devices

Evidence requirements
Evidence for the knowledge and/or skills in this outcome will be provided on a sample basis.

If a single holistic unit assessment task is adopted then at least 12 of the 24 total unit knowledge/skill items must be covered by the assessment with a minimum of three items from each of the four outcomes.

For a single holistic unit assessment, the candidate will be presented with a single problem one week prior to the submission date (or earlier if the assessment is combined with other unit assessments). It is possible to offer a choice of several problems with the candidate selecting only one. The assessment must be varied regularly. The assessment will refer to a practical situation relevant to an aspect of computing. The candidate will submit the response as a short report. Guidance on the format of the report and a minimum list of contents must be provided along with the assessment to ensure that the evidence requirements are met.

Alternatively, if the outcome is tested with one dedicated assessment, a minimum of three of the knowledge/skills items from this outcome must be tested. In this case the assessment will be a single problem stated within a practical context presented in a supervised situation. **Scientific** calculators, textbooks and notes may be used by the candidate during the assessment, but s/he should have no pre-knowledge of the assessment. The assessment must be varied on each assessment occasion.

Where an item is sampled, a candidate's response can be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- explain the advantages of introducing co-ordinate systems and give examples of different representations (the candidate is required to describe a minimum of two systems and their applications)
- draw a regular or irregular figure when presented with the co-ordinates and/or extract the co-ordinates of regular and irregular figures (the candidate should perform two operations of each type where the figures are regular with a minimum of four vertices, or one of the two operations for a complex shape)
- explain the difference between vectors and scalars. Draw vectors from co-ordinates and/or extract the components of vectors on a diagram (the candidate should perform two operations of each type in 2-d with simple examples restricted to positive and negative whole number components, or one complex example involving at least six instances of either operation)
- convert between polar and component forms by actual measurement. The candidate is expected to use a ruler, protractor and graph paper and give results that are correct to within $\pm 5\%$. One example of each type is required
- scale and offset a regular shape with at least four vertices. This may be one separate example for each type of transformation or a single example which includes both scale and offset
- identify points on a computer screen of a given resolution in terms of the appropriate co-ordinate system and units used (two examples are required)

Whichever assessment method is adopted, the candidate should attain a minimum of 60% of the available marks for each outcome to reach the standard required for a pass.

Assessment guidelines
If the preferred assessment method is four separate assessments, one of these must test this outcome. In this case it is recommended that the assessment should be completed in about 45 minutes.

The main objective in presenting this material is to enable candidates to operate effectively in computer graphical environment and in most cases the assessment will reflect this.

Outcome 3

Demonstrate a knowledge of simple functions and the ability to perform basic algebraic operations.

Knowledge and/or skills

- The ability to express simple problems as mathematical equations
- The ability to simplify and change the subject of simple equations
- The concept of a function
- The ability to obtain the equation of a straight line from a graph
- The basic properties of a circle, trigonometric and inverse trigonometric functions
- The properties of a triangle and the ability to convert between linear to polar co-ordinates

Evidence requirements
Evidence for the knowledge and/or skills in this outcome will be provided on a sample basis.

If a single holistic unit assessment task is adopted then at least 12 of the 24 total unit knowledge/skill items must be covered by the assessment with a minimum of three items from each of the four outcomes.

For a single holistic unit assessment, the candidate will be presented with a single problem one week prior to the submission date (or earlier if assessment is combined with other unit assessments). It is possible to offer a choice of several problems with the candidate selecting only one. The assessment must be varied regularly. The assessment will refer to a practical situation relevant to an aspect of computing. The candidate will submit the response as a short report. Guidance on the format of the report and a minimum list of contents must be provided along with the assessment to ensure that the evidence requirements are met

Alternatively, if the outcome is tested with one dedicated assessment, a minimum of three of the knowledge/skills items from this outcome must be tested. In this case the assessment will be a single problem stated within a practical context presented in a supervised situation. **Scientific** calculators, textbooks and notes may be used by candidate during the assessment, but s/he should have no pre-knowledge of the assessment. The assessment must be varied on each assessment occasion.

Where an item is sampled, a candidate's response can be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ♦ take a problem presented as a text description and write an equivalent algebraic equation using sensible variable names to represent the parameters (equations should include simple powers (2, 0.5) and parentheses). One correct response is required
- ♦ rearrange or simplify elementary equations of no more than four variables including parenthesis and simple powers. One correct response is required
- ♦ distinguish between relations that are functions and those that are not. From a set of six relations, the candidate is required to correctly identify four
- ♦ calculate and verify the equation of a straight line drawn on graph paper (including negative, positive zero and infinite gradient). One correct response including verification is required
- ♦ calculate the circumference and/or area of a circle (one correct response for a complex shape including straight sections and a minimum of two curved sections); explain the relationship between the sine and cosine functions and the rotation of a vector or line (a correct description including a diagram is required); explain the tan and inverse trig functions (the application to problems must be described)
- ♦ find the unknowns in a RA triangle if two pieces of information are provided (two correct responses are required; one where two sides are given and one where a side and an angle are given)

Whichever assessment method is adopted, the candidate should attain a minimum of 60% of the available marks for each outcome to reach the standard required for a pass.

Assessment guidelines
If the preferred assessment method is four separate individual assessments, one of these must test this outcome. In this case it is recommended that the assessment should be completed in about 45 minutes.

The main objective in presenting this material is to ensure that candidates can convert problems involving linear relationships or rotation into equations that can be simplified and further processed using a computer. The assessment should reflect this requirement. It is important that candidates develop a good understanding of the basic principles of algebra.

Outcome 4
Demonstrate the application of Boolean algebra to problem situations

Knowledge and/or skills
- ♦ Binary states (ON/OFF; 1/0; OPEN/CLOSED; +5V/0V; HIGH/LOW)
- ♦ The ability to identify binary problems, identify and label inputs and outputs
- ♦ The ability to produce a truth table corresponding to a problem situation
- ♦ The ability to express a truth table as a Boolean equation
- ♦ The ability to simplify a Boolean equation using algebraic methods
- ♦ The ability to represent a Boolean equation using logic gates

Evidence requirements
Evidence for the knowledge and/or skills in this outcome will be provided on a sample basis.

If a single holistic unit assessment task is adopted then at least 12 of the 24 total unit knowledge/skill items must be covered by the assessment with a minimum of three items from each of the four outcomes.

For a single holistic unit assessment, the candidate will be presented with a single problem one week prior to the submission date (or earlier if assessment is combined with other unit assessments). It is possible to offer a choice of several problems with the candidate selecting only one. The assessment must be varied regularly. The assessment will refer to a practical situation relevant to an aspect of computing. The candidate will submit the response as a short report. Guidance on the format of the report and a minimum list of contents must be provided along with the assessment to ensure that the evidence requirements are met.

Alternatively, if the outcome is tested with one dedicated assessment, a minimum of three of the knowledge/skills items from this outcome must be tested. In this case the assessment will be a single problem stated within a practical context presented in a supervised situation. **Scientific** calculators, textbooks and notes may be used by the candidate during the assessment, but s/he should have no pre-knowledge of the instrument of assessment. The assessment must be varied on each assessment occasion.

Where an item is sampled, a candidate’s response can be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- correctly identify analogue and digital signals (a minimum of four correct responses)
- correctly identify the inputs and outputs in problem situation with three or four inputs and one or two outputs; correctly label using the accepted notation (A, B, C, .. for inputs, Q1, Q2, … for outputs); state the physical situation corresponding to the logic state in each case, (eg Q1: 0 — Motor Off, 1 — Motor On). A completely correct response for a single problem situation is required
- create a truth table corresponding to the behaviour of a non-trivial system (three/four inputs one/two outputs, with the input permutations in the correct binary order). One correct response is required
- extract one or two Boolean equations from a three or four input truth table (simplification by inspection is encouraged). One correct response is required
- simplify a Boolean equation algebraically using the identities; (it is not necessary to simplify to the simplest possible form, but there should be at least four steps to the stopping point; all simplification to the candidate’s final solution must be accurate)
- construct a circuit using OR, AND and NOT gates corresponding to a Boolean equation (requiring a minimum of five gates with a minimum of one of each type and no gate having more than four inputs; one correct response is required)

Whichever assessment method is adopted, the candidate should attain a minimum of 60% of the available marks for each outcome to reach the standard required for a pass.

Assessment guidelines
If the preferred assessment method is four individual assessments, one of these must test this outcome. In this case it is recommended that the assessment should be completed in about 45 minutes.

This outcome focuses on several stages of one major activity which finally leads to the solution to a practical problem. An assignment may be presented to test each task listed above but all tasks should then be completed correctly in the time provided. It is preferable to limit the problem to three tasks, (eg it may not be a requirement to draw the equivalent logic circuit) while still presenting the problem in a practical context.

Administrative information

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Unit title:	Mathematics for Computing 1
Superclass category:	RB
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SQA Advanced Unit specification: support notes

Unit title: Mathematics for Computing 1

This part of the unit specification is offered as guidance. The support notes 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
The objective of the unit is to enable candidates to apply mathematical methods to computer-related problems or apply computer calculation methods to general problems. It is essential that the basic theory for each outcome be delivered in this context. While time will not permit all relevant aspects of computing to be taught in depth, the assessment may be designed around information candidates have encountered in other units. Candidates should be introduced to the processes of research. General delivery guidance is presented below:

Representing and manipulating numbers in scientific notation
Explain clearly that integers are associated with counting and real numbers with measurement and calculation. The negative numbers should be covered for candidates uncomfortable with the concept; use the number line to ensure the answers to calculations such as 1-2, -1-2, and 1—2 are clear.
Describe how computer memory is organised as bits and bytes and show that 256 distinct patterns of 1s and 0s can be stored, each of which associated with an integer in the range –128 to +127. Explain how 2 and 4 bytes together can extend this range. Identify the data type associated with each in common computing languages.

Demonstrate that real numbers often contain more information than is useful or may wrongly suggest high precision if derived using a calculator. People work to 1, 2, or 3 significant figures in common life and perform rounding to make them manageable. Discuss rounding rules. It is sufficient to say that rounding up takes place if the digit following the cut off to the last significant figure is greater than or equal to 5. More complex rules may be discussed with candidates whose interest lies in financial calculations.

When presented with a number, candidates should be shown how to estimate the precision on the assumption that the number may have been rounded. Optionally, the resultant error when two numbers with an error are added, subtracted, multiplied and divided may be stated or shown with practical examples.

The use of powers to describe numbers that are multiples of 10 should be described. Take care to explain that 1 is 10^0. Describe negative powers of 10. Describe milliseconds, microseconds, nanoseconds and the relationship to frequency - MegaHertz and GigaHertz. Explain how numbers in this format are multiplied and divided. Advanced candidates may optionally be introduced to the concept of logarithms and the benefits when charting data in spreadsheets.

Explain scientific notation and the slight difference in the way floating-point numbers are stored in computer memory (mantissa and exponent). Describe the data types for real numbers for common programming languages and the number of bytes used to store data.

Explain how computers (and calculators) deal with rounding to ensure 10 / 3 * 3 = 10 and not 9.9999.

Typical assessment problems for this outcome might include:

1. A Pentium III processor with a bus clocked at 133 MHz is operating at maximum speed. What are the number of bytes transferred per second? What is the maximum access time of the memory if it is to operate correctly? If the memory integrated circuit is located a wiring distance of 0.06 m from the microprocessor, what is the propagation delay for signals (assuming the signals travel at 3.0×10^8 m/s)? Express the result in scientific notation.
2. A database system is required to store financial data. There can be up to 10,000 clients but for security they are referenced by number only. Five pieces of financial data (that may reach £9,999,999.99) are stored for each. What is the most efficient way to define the database structure and what is the maximum file size?

Note that several questions of this type may be required to provide satisfactory evidence of achievement.

Other topics could include baud rate calculations, comparisons between parallel and serial transmission, hard disk and CD ROM data access calculations etc.

Co-ordinate Systems, Vectors and Linear Transformations

There should be a discussion of global co-ordinates (geographical maps) to introduce the subjects. Problems with latitude and longitude should be mentioned after defining the units for measuring angles (degrees and radians). The concept of the origin should be introduced.

2-d Cartesian co-ordinates with an arbitrary origin may then be developed. The benefits of an abstract representation should be made clear. A set of practical exercises involving drawing letters or geometrical objects will ensure the candidate becomes familiar with the notation used. Operations on the points that define the shape should be practiced to demonstrate translation and scaling. Rotation should be mentioned but need not be implemented. Candidates may optionally be introduced to 2-d projections of 3-d objects and perspective. This would be useful for those interested in CAD.

The theory can be applied to the computer screen. One relevant type should be described, for example a 640x480-pixel display with 4:3 aspect ratio and the origin at the top left. It would be beneficial to explain that shapes described as vectors take up less space to store (vector graphics) than a pixel-by-pixel description (bit map).

Vectors should be described in general. The component and polar representation of vectors can be shown to be equivalent. More advanced candidates may optionally be introduced to Pythagoras' theorem and the equation of a circle.

Typical assessment problems for this outcome might include:

1. Describe how a message window with properties Message.Left, Message.Top, Message.Height and Message.Width could change to ensure it remains in the centre of a container window as the size of the container window is adjusted. The container properties are Container.Left, Container.Top, Container.height and Container.Width. Screen co-ordinates are Screen.X and Screen.Y.
2. Using the command Line (X1, Y1)-(X2, Y2) which draws a line between two points, describe how the letter A could be drawn on the screen at position (x,y) and with height h and width w.

Note that several questions of this type may be required to provide satisfactory evidence of achievement.

Algebra and Functions

The first task would involve a large number of activities such as:

1. One Pound is worth 1.61 Euros. Express this as an equation.

   Let P be the number (or amount) of Pounds and E be the number (or amount) of Euros. Then:

   $$P = 1.61\ E$$

2. Neglecting air resistance, the distance travelled by an object falling under gravity is ½ times the acceleration due to gravity times the time in seconds since it was dropped multiplied by itself. Express this as an equation.

   Let s be the number of seconds, g be the gravitational acceleration d the distance dropped, then

   $$d = ½\ g\ t^2$$

3. The instantaneous power produced by an electric bar heater (in watts) is equal to the current flow squared times the electrical resistance of the wire forming the heater. Generally speaking, the resistance is not known but is equal to the peak mains voltage (240 volts) divided by the current flow. Express the instantaneous power as an equation.

   Let P be the power, I be the current and R be the resistance. Then

   $$P = I^2\ R = I^2\ (V/I)$$

4. If a farmer has 1000 metres of fence which he uses to enclose a rectangular area. Express the area in terms of the length of one side.

   Let A be the area, L be the length of one side and B be the breadth. Then

   $$A = L\ B \text{ but } B = 500 – L \text{ hence } A = L(500 – L)$$

The specific activities should as far as possible relate to day-to-day tasks or tasks encountered in the candidate specific interest area. The connection to programming and spreadsheets should be emphasised (including the identification of the parameter names in equations with variables and a consideration of variable types). In combination with other units, candidates may write simple programs to make calculations or produce graphs using a spreadsheet. Explain that / and * are commonly used in computing in place of the division and multiplication signs. It is important to familiarise candidates with the power notation (including square roots), the use of brackets and <u>know the precedence of operators</u> (1 + 2 x 3 is not 9!). Candidates should be aware of parameter units and the requirement that all numbers should be displayed with appropriate units following a calculation.
The second task should develop the problems described before. For example:

1. Derive an equation that will give the number of Euros that can be exchanged for a certain number of Pounds.
2. If the object is dropped from initial height 100 metres, express the height with time as it drops. How long will it take to hit the ground?
3. Simplify the equation developed in the equivalent problem above.
4. Using a computer program or spreadsheet, estimate the length of the rectangle that will give the greatest area.

The objective is for the candidate to be able to express the problem as an equation. It is not necessary to introduce problems that call for simultaneous linear equations.

For the third and fourth tasks, describe the concept of a mapping, but limit the discussion to a mapping from the set of points on the x-axis to points on the y-axis. Define a function and show that a straight line is a function and that for each point on the line the relationship between the x and y co-ordinates can be described an equation of the type $y = mx + c$. Explain how the constants m and c are obtained (including the special case of the line $x = a$) and how the equation can be verified by fitting points from the line. It would be helpful to produce a spreadsheet with a chart where the candidate can see how the line changes as m and c are altered.

The theory should be applied to a practical problem such as:

1. The time taken to cook 2 kg of lamb is 150 minutes and it takes 270 minutes to cook 4 kg of lamb. Assuming a linear relationship, how long would it take to cook 1 kg of lamb?

The last tasks introduce trigonometry. Some time should be taken to discuss the properties of a circle and ensure the candidate can find the area and circumference of combinations of circles, semi-circles and quarter circles.

The sine and cosine functions must be demonstrated as vertical and horizontal projections with angle (define 0 degree position and direction of rotation). The values are not exactly calculated from anything but exist as a table referenced by a calculator or computer. Define tangent and the concept of inverse trigonometric functions when the subject of tan equation is changed. It is left to the centre to decide whether to use degrees or radians (or time) as a measurement unit in the delivery of the material. This theory can be applied to the right-angled triangle with practical problems where one side and one angle are known.

It may be beneficial for candidates who wish to specialise in networks, telecommunications or multimedia to introduce the concept of an audio wave or electrical wave at audio frequencies, modulation, superposition of waves and digital sampling.

Boolean Algebra

The purpose of the outcome is to provide the candidate with at least one method for solving Boolean problems. An algebraic approach should adopted for continuity and reinforce the learning as the underpinning algebraic concepts were introduced in Outcome 3. It is not recommended that Venn diagrams and the Union/Intersection operators be used to introduce the subject or used to simplify Boolean equations, but the candidate can be encouraged to research these alternative methods. At the discretion of the centre, Karnaugh maps may be used, but it is not a requirement. Advanced candidates may optionally be introduced to circuits using NOR and NAND gates which can only be simplified using de Morgan’s theorem.

The candidate should be able to clearly identify problems that can be solved by Boolean methods. Ensure with a series of practical problems that the inputs and outputs can be correctly identified, consistently labelled, and the states for each input and output are defined. It is appropriate here to distinguish between digital and analogue signals and describe to the candidates how a computer can interface to analogue systems.

The truth table must be constructed. It should be noted that the candidate may not be aware of the binary representation of decimal numbers and may have to be shown the consistent way to list all the possible input combinations. In some cases, outputs can be ‘don’t care’. It is not necessary to carry these through a specific value can be allocated at the initial stage.

The candidate is shown how to generate the equivalent Boolean equation from the truth table from the table. One simple method is to instruct the candidate to write out a description of the output in English:
Q is 1 when A is 1 and B is 0 or A is 1 and B is 1

then replace statements of the type *X is 1* with X, *X is 0* with X’, *AND* with **.** , *OR* with +, *when* with = to give:
$Q = A \cdot B' + A \cdot B$

The candidate will be familiarised with the properties of (and symbols for) AND, OR and NOT gates as examples of Boolean systems. A range of identities can be proven using these gates. The method of achieving more complex output configurations by combining gates should is shown.

It must be made clear that the . and + symbols in this context do not mean multiply and addition, but they can be treated as such, as far as the distributive, associative and commutative laws are concerned. Using the rules of algebra, the equation can be simplified. There are three important methods that must be learnt:

1. A.B + A.B’ = A.(B+B’) = A.1 = A
2. A.B.C + A.B.C’ + A.B’.C’ = A.B.C + A.B.C’ + A.B.C’ + A.B’.C’ = A.B.(C+C’) +A.C’.(B+B’) = A.B.1 + A.C’.1 = A.B + A.C’
3. A + A.B + A.C = A

A complete list of identities should be made available to the candidate.

The simplified Boolean equation should be implemented with AND, OR and NOT gates to solve the problem.

To summarise, the candidate must be able to execute the following sequence for a problem:

> *Identify inputs & outputs → Produce truth table → Express Boolean equation → Simplify equation → Produce equivalent circuit*

If it is desirable that the general principles of sequential logic should be described in very general terms (latch/ memory, counters) along with applications, but there is no need to describe how these components are constructed from basic logic gates.

It is then possible to understand how the components of a computer are designed. Boolean algebra also has application in simplifying complex SQL search criteria.

Typical assessment problems for this outcome might include:

1. A safety system consists of three identical sensors measuring the critical temperature. If at least two sensors indicate a fault, the machine is shut down. Design a circuit to implement this.
2. Data is sent along a single line. Design a circuit to generate a parity bit for each three data bits.

Assessment may also cover the operation of simplified components of a computer (addition unit, decoder etc).

Guidance on the delivery and assessment of this unit

The unit may be assessed by a single assignment presented to the candidate for completion within one week. The assignment must be problem based with a well-defined solution (or a limited number of solutions). It must cover all four outcomes. Clear guidelines on how the solution is to be presented must be supplied with the task. A marking scheme and checklist is required to show that a minimum of 12 knowledge/skills (the assignment may test a greater number) have been demonstrated by the candidate, and that the candidate has achieved a minimum of 60% pass rate as specified for the evidence requirements for each outcome. If the assignment is extended to assess another unit, the time for completion may be extended at the discretion of the centre.

The alternative assessment method is to present the candidate with a single problem in a supervised situation for each of the four outcomes. It is expected that each assignment will take about 45 minutes (though this may be varied by the centre) and is presented after the outcome is taught rather than all together at the end of the unit. In all cases, the assignments should be presented as a practical problem relevant to the candidate's needs, the solution demonstrating at least three of the knowledge/skills items for that outcome. Careful design of assessments is necessary to ensure that the minimum assessment evidence requirement for the selected knowledge/skill items is met. Access to the textbooks, course notes and calculators are all permitted except where the testing of candidate knowledge/skills prevents it.

All assignments should be changed each time they are presented so that candidates cannot anticipate the knowledge/skills items to be sampled.

The level at which the material is presented must not relate to the ability of the candidate but must instead be consistent with SCQF Level 7. This is not a generic maths unit but is specific to computing. Centres are encouraged to adopt good course design with significant parts of this unit linked to or embedded within the other units that make up the course.

The use of software tools, CAL, MathCad, MatLab and Internet resources is to be encouraged.

Open learning

If this unit is delivered by open- or distance-learning methods, additional planning and resources may be required for candidate support, assessment and quality assurance.

A combination of new and traditional authentication tools may have to be devised for assessment and re-assessment purposes.

For further information and advice, please see *Assessment and Quality Assurance for Open and Distance Learning* (SQA, February 2001 — publication code A1030).

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.

General information for candidates

Unit title: Mathematics for Computing 1

In this unit you will learn about and use mathematical methods appropriate to computing. There are four outcomes. In the first, you will learn about scientific notation and rounding. This is important because it is similar to the way computers store numbers. When programming, you will then be aware of what is happening in the computer memory when declaring variables.

Co-ordinates and transformations are covered by Outcome 2. These are the skills required to create computer graphics. Outcome 3 focuses on functions and algebra. This is useful when you have to use a computer to perform calculations or manipulate numbers. In the last outcome, you will be introduced to design with logic gates. Computers are based entirely on logic gates and seeing how a few gates can be combined to perform a useful function gives a good insight into the workings of a computer.

There may be one project-type assessment at the end of the unit or there may be four short assessments, one for each outcome and none should take longer than 45 minutes. In all cases, the assessment will relate to a practical problem situation which you will have to analyse.

This unit is only beneficial if you are interested in computing or are doing a computing course. It teaches methods that are very useful if you want to be a programmer or if you want to know how the computer works at a hardware level.

While the unit begins from first principles, in practice the contents are too much for someone to learn in the 36-40 hours that will normally be allocated. You should have a mathematics or numeracy qualification to at least National 4 level. If you do not have this you should complete the Mathematics for Computing Foundation course.