



# GCE

## Course Specification

**Subject:** Use of Mathematics  
Advanced Subsidiary GCE (9361)  
Advanced GCE (9362)

**Year:** Pilot 2009

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We will notify centres in writing of any changes to this specification.

You can get further copies of this specification from:  
The GCE Mathematics subject office  
[mathematics-gce@aqa.org.uk](mailto:mathematics-gce@aqa.org.uk)

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Registered address AQA, Devas Street,  
Manchester M15 6EX.  
Dr Michael Cresswell Director General.

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# 1 Introduction

## 1.1 Why choose AQA?

It's a fact that AQA is the UK's favourite exam board and more students receive their academic qualifications from AQA than from any other board. But why does AQA continue to be so popular?

### Specifications

Ours are designed to the highest standards, so teachers, students and their parents can be confident that an AQA award provides an accurate measure of a student's achievements. And the assessment structures have been designed to achieve a balance between rigour, reliability and demands on candidates.

### Support

AQA runs the most extensive programme of support meetings; free of charge in the first years of a new specification and at a very reasonable cost thereafter. These support meetings explain the specification and suggest practical teaching strategies and approaches that really work.

### Service

We are committed to providing an efficient and effective service and we are at the end of the phone when you need to speak to a person about an important issue. We will always try to resolve issues the first time you contact us but, should that not be possible, we will always come back to you (by telephone, email or letter) and keep working with you to find the solution.

### Ethics

AQA is a registered charity. We have no shareholders to pay. We exist solely for the good of education in the UK. Any surplus income is ploughed back into educational research and our service to you, our customers. We don't profit from education, you do.

If you are an existing customer then we thank you for your support. If you are thinking of moving to AQA then we look forward to welcoming you.

## 1.2 Why choose GCE Use of Mathematics?

- This pilot specification covers both the AS and A level in Use of Mathematics, and also the constituent advanced level Free-Standing Mathematics Qualifications (FSMQ) of which they are composed, and which are stand-alone short qualifications in their own right.
- Use of Mathematics and FSMQ courses were developed to enable the study of mathematical topics in practical, real-life contexts. As Professor Adrian Smith stated in his 2004 report into Mathematics 14-19, students involved in FSMQ courses recognise the relevance of the mathematics as they model the real world and develop skills which are readily transferable to either the real world or to their other studies.
- The use of a data sheet, which is issued two weeks before the examination, familiarises students with the scenarios and the vocabulary that will be required in the examination. This helps candidates to apply their mathematical knowledge to the real-life situations used in the examination paper.
- This pilot qualification is the first ever full A-level available in Use of Mathematics. Students now have the opportunity to pursue practical and relevant mathematics courses to the same level as traditional GCE Mathematics.
- The pilot GCE Use of Mathematics will be recognised by UCAS. UCAS points are the same as for any other AS or A level qualification:

### Advanced Subsidiary

Grade	A	B	C	D	E
Points	60	50	40	30	20

### A level

Grade	A	B	C	D	E
Points	120	100	80	60	40

- Advanced FSMQ units are each worth UCAS points.

### Advanced FSMQ

Grade	A	B	C	D	E
Points	20	17	13	10	7

- Both Advanced FSMQ and GCE Use of Mathematics are accredited for pre-16 use.
- The pilot GCE Use of Mathematics is substantially altered from the existing AS Use of Mathematics. There are no longer any 50% portfolio units. Portfolio work is the sole method of assessment for the Mathematical Applications unit at A2; all other units are now assessed by written paper only. More choice of applications unit is available. Units in Calculus and Applying Mathematics will now be assessed at A2, not AS, standard.
- Owing to these significant changes to the specification, it is **not** possible to combine a non-pilot AS with a pilot A2 to form an A-level. A-level Use of Mathematics must comprise 6 units, all of which must be from the pilot specification only.

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## 1.3 How do I start using this specification?

- This is a restricted pilot. You must contact the subject office for more information at [mathematics-gce@aqa.org.uk](mailto:mathematics-gce@aqa.org.uk)

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## 1.4 How can I find out more?

### Ask AQA

You have 24-hour access to useful information and answers to the most commonly-asked questions at <http://www.aqa.org.uk/rn/askaqa.php>

If the answer to your question is not available, you can submit a query for our team. Our target response time is one day.

### Teacher Support

If you need to contact the Teacher Support team, you can call us on 01483 477860 [or email us at teachersupport@aqa.org.uk](mailto:teachersupport@aqa.org.uk) . However, it is more likely that the Subject Administration team will be able to provide support for teachers of this pilot qualification. Contact us at [mathematics-gce@aqa.org.uk](mailto:mathematics-gce@aqa.org.uk)

## 2 Specification at a glance

### AS Examination 9361

AS Use of Mathematics comprises the compulsory unit Algebra plus two applications units.

#### Algebra USE1

One written paper with pre-release data sheet; calculators allowed

1 hour

$33\frac{1}{3}\%$  of the total AS marks

$16\frac{2}{3}\%$  of the total A-level marks

Plus any two of the following:

#### FSMQ Data Analysis 9993 \*

One written paper with pre-release data sheet; calculators allowed

1 hour

$33\frac{1}{3}\%$  of the total AS marks

$16\frac{2}{3}\%$  of the total A-level marks

#### FSMQ Hypothesis Testing 9994 \*

One written paper with pre-release data sheet; calculators allowed

1 hour

$33\frac{1}{3}\%$  of the total AS marks

$16\frac{2}{3}\%$  of the total A-level marks

#### FSMQ Dynamics 9995

One written paper with pre-release data sheet; calculators allowed

1 hour

$33\frac{1}{3}\%$  of the total AS marks

$16\frac{2}{3}\%$  of the total A-level marks

#### FSMQ Mathematical Principles for Personal Finance 9996

One written paper with pre-release data sheet; calculators allowed

1 hour

$33\frac{1}{3}\%$  of the total AS marks

$16\frac{2}{3}\%$  of the total A-level marks

#### FSMQ Decision Mathematics 9997

One written paper with pre-release data sheet; calculators allowed

1 hour

$33\frac{1}{3}\%$  of the total AS marks

$16\frac{2}{3}\%$  of the total A-level marks

\* FSMQ Data Analysis is not a prerequisite for FSMQ Hypothesis Testing (and vice-versa). The two units are independent of each other.

## A2 Examination

A2 Use of Mathematics comprises three compulsory units. There is no choice of unit at A2.

### **FSMQ Calculus 9998**

One written paper with pre-release data sheet; calculators allowed

1 hour

$33\frac{1}{3}$  % of the total A2 marks

$16\frac{2}{3}$  % of the total A-level marks

### **Mathematical Applications USE2**

60 hour portfolio assessment, marked by the centre and moderated by AQA

$33\frac{1}{3}$  % of the total A2 marks

$16\frac{2}{3}$  % of the total A-level marks

### **Mathematical Comprehension USE3**

One written comprehension paper in two sections with pre-release data sheet; graphics calculator required

$1\frac{1}{2}$  hours

$33\frac{1}{3}$  % of the total A2 marks

$16\frac{2}{3}$  % of the total A-level marks

## A Level Use of Mathematics 9362

A level Use of Mathematics comprises an AS plus an A2; both must be from the pilot schemes described above.

## FSMQ Advanced 9993 – 9998

FSMQ Advanced units can also be entered as stand-alone short qualifications in their own right. For a list of the FSMQ certificates available, see section 5.6.

### **FSMQ Advanced**

One written paper with pre-release material; calculators allowed

1 hour

100% of the total FSMQ marks

## 3 Subject Content by Unit

### 3.1 Algebra (USE1)

Note that Algebra is **not** a free-standing qualification in the pilot scheme and no separate FSMQ certificate is available for the unit outside AS and A level Use of Mathematics.

Before you start this qualification

**You must be able to:**

**This includes:**

plot by hand accurate graphs of paired variable data and linear and simple quadratic functions in all four quadrants	quadratics of the type $y = ax^2 + bx + c$
recognise and predict the general shapes of graphs of direct proportion, linear and quadratic functions	quadratics of the type $y = kx^2 + c$
fit linear functions to model data pairs	calculating gradient and intercept for linear functions
rearrange basic algebraic expressions by <ul style="list-style-type: none"> <li>collecting like terms</li> <li>expanding brackets</li> <li>extracting common factors</li> </ul>	
solve basic equations by exact methods	pairs of linear simultaneous equations
use power notation	positive and negative integers and fractions
solve quadratic equations	by at least one of the following methods: <ul style="list-style-type: none"> <li>use of a graphics calculator</li> <li>use of formula <math display="block">x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}</math> (which must be memorised)</li> <li>completing the square</li> </ul> <p>Solution by factorisation is also required where the quadratic factorises.</p>

---

## Using calculators and computers

When carrying out calculations, you may find the use of a standard scientific calculator sufficient.

You should learn to use your calculator effectively and efficiently. This will include learning to use:

- memory facilities
- function facilities (e.g.  $e^x$ ,  $\sin x$ , ...)

It is important that you are also able to carry out certain calculations without using a calculator, using both written methods and 'mental' techniques.

Whenever you use a calculator you should record your working as well as the result.

**You should learn to use a graphics calculator or graph plotting software (possibly a spreadsheet) on a computer to:**

**This includes:**

---

plot graphs of paired variable data

---

plot graphs of functions

---

use function facilities

$e^x$ ,  $\sin x$ ,  $\cos x$ , etc.

---

trace graphs (if possible)

finding intersections of functions with other functions and axes

---

use zoom facilities (if possible)

finding significant features of functions such as turning points

## Fitting functions to data

You should:	This includes:
be familiar with the graphs of quadratic functions of the form $y = ax^2 + bx + c$ $y = (rx - s)(x - t)$ $y = m(x + n)^2 + p$	<ul style="list-style-type: none"><li>• knowing the general shape, orientation, position etc. of a given quadratic</li><li>• relating the shape and position of a graph of <math>y = m(x + n)^2 + p</math> to <math>m</math>, <math>n</math> and <math>p</math></li><li>• relating zeroes of a function <math>f(x)</math> to roots of the equation <math>f(x) = 0</math></li></ul>
be familiar with the graphs of functions of powers of $x$ $y = kx^{\frac{1}{2}} = k\sqrt{x}$	<ul style="list-style-type: none"><li>• <math>y = kx^{-2} = \frac{k}{x^2}</math>; <math>y = kx^{-1} = \frac{k}{x}</math>;</li><li>• knowing the general shape, orientation and position of such a function</li></ul>
be familiar with the graphs of trigonometric functions of the form: $y = A \sin(mx + c)$ $y = A \cos(mx + c)$	<ul style="list-style-type: none"><li>• knowing the general shape and position of a given trigonometric function</li><li>• using correctly the terms amplitude, frequency and period</li></ul>
be familiar with the graphs of exponential functions of the form $y = ka^{mx} \text{ and } y = ke^{mx}$ ( $m$ positive or negative)	understanding ideas of exponential growth and decay

<p>be familiar with graphs of natural logarithmic functions of the form <math>y = a \ln(bx)</math></p>	<p>understanding the logarithmic function as the inverse of the exponential function</p>
<p>understand the idea of inverse functions and be able to find graphically the inverse of a function for which you have a graph</p>	<p>using reflection in the line <math>y = x</math></p>
<p>have an understanding of how geometric transformations can be applied to basic functions. This understanding should assist you when fitting a function to data.</p>	<ul style="list-style-type: none"> <li>• Using <ul style="list-style-type: none"> <li>(i) translation of <math>y = f(x)</math> by vector <math>\begin{bmatrix} 0 \\ a \end{bmatrix}</math> to give <math>y = f(x) + a</math> (eg <math>y = \sin x</math>, <math>y = 4 + \sin x</math>)</li> <li>(ii) translation of <math>y = f(x)</math> by vector <math>\begin{bmatrix} a \\ 0 \end{bmatrix}</math> to give <math>y = f(x + a)</math> (eg <math>y = \sin x</math>, <math>y = \sin(x + 60^\circ)</math>)</li> <li>(iii) stretch of <math>y = f(x)</math> scale factor <math>a</math> with invariant line <math>x = 0</math>, to give <math>y = a f(x)</math> (eg <math>y = \sin x</math>, <math>y = 5 \sin x</math>)</li> <li>(iv) stretch of <math>y = f(x)</math> scale factor <math>a</math> with an invariant line <math>y = 0</math> to give <math>y = f(ax)</math> (eg <math>y = \sin x</math>, <math>y = \sin 2x</math>)</li> </ul> </li> <li>• being able to describe geometric transformations fully</li> </ul>
<p>be able to determine parameters of non-linear laws by plotting appropriate linear graphs</p>	<p>Applications only in the two cases below</p> <ul style="list-style-type: none"> <li>• <math>y = ax^2 + b</math> (plotting <math>y</math> against <math>x^2</math>),</li> <li>• <math>y = ax^b</math> and <math>y = a^x</math> using natural logarithms</li> </ul>

## Interpreting models

### You should learn to:

### This includes:

---

understand

- how functions can be used to model real data
- the limitations that a function may have when used to model data (e.g. being valid over a restricted range)

---

find and use intercepts of functions with axes and other functions to make predictions about the real situation investigated

---

find local maximum and minimum points and understand in terms of the real situation their physical significance

---

calculate and understand gradient at a point on the graph of a function using tangents drawn by hand

using the zoom and trace facilities of a graphics calculator or computer software if possible

---

use and understand the correct units in which to measure rates of change

---

interpret and understand gradients in terms of their physical significance

---

identify trends of changing gradients and their significance both for functions that you know and curves drawn to fit data

## Using algebraic techniques

### You should learn to:

### This includes:

---

rearrange any quadratic function into the forms

$$y = ax^2 + bx + c$$

$$y = a(x + b)^2 + c$$

quadratics expressed in the form  $y = (ax + b)(x + c)$

---

find maximum and minimum turning points of quadratics by completing the square

i.e. expressing in the form

$$y = a(x + b)^2 + c$$

---

solve polynomial equations of the form  $ax^n = b$

---

solve trigonometric equations of the form:

$$A \sin(mx + c) = k$$

$$A \cos(mx + c) = k$$

---

solve exponential equations of the form  $A \exp(mx + c) = k$

---

understand how logarithms can be used to represent numbers

- using natural logarithms
- 

know and use the laws of logarithms

- $\log(ab) = \log a + \log b$

- $\log\left(\frac{a}{b}\right) = \log a - \log b$

- $\log a^n = n \log a$

---

use logarithms to convert equations to logarithmic form

for example

$$y = ka^{mx} \text{ gives}$$

$$\log y = \log k + mx \log a$$

---

use logarithms to solve equations

- $a^x = b$  using natural logarithms
-

## 3.2 FSMQ Data Analysis (9993)

	<b>You should learn:</b>	<b>Including:</b>
<b>Statistical diagrams</b>	<ul style="list-style-type: none"> <li>• Box and whisker plot</li> <li>• Back-to-back stem and leaf diagram</li> <li>• Histogram</li> <li>• Cumulative frequency diagram</li> </ul>	<ul style="list-style-type: none"> <li>• Grouping of data</li> <li>• Ideas of symmetry, skew and multi-modal distributions. Measures of skewness are not required.</li> </ul>
<b>Measures of location and spread</b>	<ul style="list-style-type: none"> <li>• Mean (<math>\bar{x}</math>), median, mode</li> <li>• Upper and lower quartiles</li> <li>• Percentiles</li> <li>• Range and inter-quartile range</li> <li>• Standard deviation (<math>\sigma_n</math> and <math>\sigma_{n-1}</math>)</li> <li>• Outliers</li> </ul>	<ul style="list-style-type: none"> <li>• Comparing and contrasting data sets</li> <li>• Using a calculator to find <math>\bar{x}</math>, <math>\sigma_n</math> and <math>\sigma_{n-1}</math></li> </ul>
<b>Bivariate data</b>	<ul style="list-style-type: none"> <li>• Scatter diagrams</li> <li>• Ideas of positive, negative and no correlation</li> <li>• Pearson's product moment correlation coefficient (<math>r</math>)</li> <li>• Regression lines and the equation of the line of best fit</li> </ul>	<ul style="list-style-type: none"> <li>• Use of mean values</li> <li>• Using a calculator to find <math>r</math> and regression line coefficients. Interpretation of these results</li> <li>• Understanding that correlation does not imply causation</li> <li>• Understanding that <math>r</math> is only a measure of <i>linear</i> correlation</li> </ul>
<b>Normal distribution</b>	<ul style="list-style-type: none"> <li>• Features of a normal distribution; to include continuous data, symmetry and 2/3rds and 95% rules</li> <li>• Standard normal distribution with mean 0 and standard deviation 1</li> <li>• Use of tables to find probabilities and expected frequencies</li> </ul>	<ul style="list-style-type: none"> <li>• Understanding how a theoretical distribution can be a model for a real population</li> </ul>

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### 3.3 FSMQ Dynamics (9995)

#### Prior learning

Candidates will need knowledge of the following.

Trigonometry:

- Use of Sin, Cos and Tan (but not the Sine or Cosine rules)

Algebra:

- Collection of like terms and solution of linear equations such as  $3 + 5t = 24 - 5t$

Solution of a quadratic equation by at least one of the following methods:

- use of a graphics calculator
- use of formula  $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$  (which must be memorised)
- completing the square

Solution by factorisation will be acceptable where the quadratic factorises.

---

#### Formulae

Candidates should learn the following formulae which may be required to answer questions.

Constant Acceleration  
Formulae

$$s = ut + \frac{1}{2}at^2$$

$$\mathbf{s} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$$

$$v = u + at$$

$$\mathbf{v} = \mathbf{u} + \mathbf{a}t$$

$$s = \frac{1}{2}(u + v)t$$

$$\mathbf{s} = \frac{1}{2}(\mathbf{u} + \mathbf{v})t$$

$$v^2 = u^2 + 2as$$

Weight

$$W = mg$$

Momentum

$$\text{Momentum} = mv$$

Newton's Second  
Law

$$F = ma \text{ or Force} = \text{rate of change of momentum}$$

Friction

$$F = \mu R$$

No knowledge of calculus is required in this unit.

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## Mathematical Modelling

Use of assumptions in simplifying reality.

Candidates are expected to use mathematical models to solve problems by making assumptions to create a simple model of a real situation.

Candidates are expected to use experimental or investigational methods to explore how the mathematical model used relates to the actual situation.

Mathematical analysis of models.

Modelling will include the appreciation that:

it is appropriate at times to treat relatively large moving bodies as point masses;

the friction law  $F = \mu R$  is experimental;

the force of gravity can be assumed to be constant only under certain circumstances.

Interpretation and validity of models.

Candidates should be able to comment on the modelling assumptions made when using terms such as particle, light, inextensible string, smooth surface and motion under gravity. Candidates should be familiar with the use of the words; light, smooth, rough, inextensible, thin and uniform.

Refinement and extension of models.

---

## Vectors

Understanding of a vector; its magnitude and direction.

Addition and subtraction of two vectors.

Multiplication of a vector by a scalar.

Addition and subtraction of quantities using vectors.

Magnitude and direction of quantities represented by a vector.

Candidates may work with the **i, j** notation or column vectors, but questions will be set using the column vector notation.

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## Kinematics in One and Two Dimensions

Displacement, speed, velocity, acceleration.

Understanding the difference between displacement and distance.

Understanding the difference between velocity and speed.

Sketching and interpreting kinematics graphs.

Use of gradients and area under graphs to solve problems.

The use of Calculus is **NOT** required for this unit.

Knowledge and use of constant acceleration equations.

$$s = ut + \frac{1}{2}at^2 \qquad \mathbf{s} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$$

$$v = u + at \qquad \mathbf{v} = \mathbf{u} + \mathbf{a}t$$

$$s = \frac{1}{2}(u + v)t \qquad \mathbf{s} = \frac{1}{2}(\mathbf{u} + \mathbf{v})t$$

$$v^2 = u^2 + 2as$$

Application of vectors in two dimensions to represent position, velocity or acceleration, including the use of unit vectors **i** and **j**.

Candidates may work with the **i, j** notation or column vectors, but questions will be set using the column vector notation.

Vertical motion under gravity.

Average speed and average velocity.

Magnitude and direction of quantities represented by a vector.

Finding position, velocity, speed and acceleration of a particle moving in two dimensions with constant acceleration.

The solution of problems such as when a particle is at a specified position or velocity, or finding position, velocity or acceleration at a specified time.

Use of constant acceleration equations in vector form, for example,  $\mathbf{v} = \mathbf{u} + \mathbf{a}t$ .

---

## Forces

Drawing force diagrams, identifying forces present and clearly labelling diagrams.	Candidates should distinguish between forces and other quantities such as velocity, that they might show on a diagram.
Force of gravity (Newton's Universal Law not required).	The acceleration due to gravity, $g$ , will be taken as $9.8 \text{ ms}^{-2}$ .
Friction, limiting friction, coefficient of friction and the relationship of $F = \mu R$	
Tensions in strings and rods.	
Knowledge that the resultant force is zero if a body is in equilibrium.	Find the unknown forces on bodies that are at rest or moving with constant velocity.  Candidates will not be expected to resolve forces or find the components of forces. Candidates will not be expected to use the triangle of forces.

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## Momentum

Concept of momentum	Momentum as a vector in one or two dimensions. (Resolving velocities is not required.) Momentum = $mv$
The principle of conservation of momentum applied to two particles for direct impacts in one dimension.	Knowledge of Newton's law of restitution is not required.

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## Newton's Laws of Motion

Newton's three laws of motion.	Problems may be set in one or two dimensions and may include the use of vectors.
Simple applications of the above to the linear motion of a particle of constant mass.	
Application of Newton's second law to particles moving with constant acceleration.	Candidates will be expected to find the acceleration of a body if the forces acting are specified, or unknown forces if the acceleration is given.
Use of $F = \mu R$ as a model for dynamic friction.	

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## Projectiles

Motion of a particle moving freely under uniform gravity in a vertical plane.

Calculate range, time of flight and maximum height.

Modification of equations to take account of the height of release.

Candidates will be expected to state and use equations of the form  $x = V\cos at$  and  $y = V\sin at - \frac{1}{2}gt^2$ .

Candidates should be aware of any assumptions they are making.

Formulae for the range, time of flight and maximum height should not be quoted in examinations. Inclined plane and problems involving resistance will not be set. The use of the identity  $\sin 2\theta = 2\sin\theta\cos\theta$  will not be required.

Candidates may be expected to find initial speeds or angles of projection.

## 3.4 Mathematical Principles for Personal Finance (9996)

The content of this unit covers three areas: the value of money over time, indices used to measure key financial information and tables and diagrams of financial information.

### The value of money over time

The value of money varies over time. Imagine you were asked if you would like to be given a £1000 now or in ten years time. What would be your response? Even if you didn't spend the money for ten years it would be better if you had the money now: you could invest it and it would be worth more at the end of the ten years. If, for example, you were able to invest it at 4% interest per year, after 10 years it would be worth £1480. Of course, in that period due to inflation, depending on what you

spend the £1000 on it is likely to cost you more. However, some goods come down in price over time: this is often true, for example, for computer equipment. A question you need to consider then is, what is the cost of what you might want to buy likely to be at the end of the ten year period relative to what it costs now?

Understanding how money varies over time is, therefore, a very important idea to consider when making all manner of financial decisions

### What you need to learn

#### Financial aspect

The key idea of present and future values

Interest rates:

AER

calculating the annual effective interest,  $r$ , rate given a nominal interest rate,  $i$

Calculating the future value of a present sum (using ideas of compound interest)

Calculating the present value of a future sum

#### Mathematical understanding

present value,  $PV$   
future value,  $FV$

$$r = \left(1 + \frac{i}{n}\right)^n - 1$$

where  $n$  is the number of compounding periods per year

$$FV = PV(1+r)^n$$

where  $r$  is the interest rate expressed as a decimal and  $n$  is the number of time periods

$$PV = \frac{FV}{(1+r)^n}$$

#### This includes

understanding as a geometric series

$$a, ar^2, ar^3, \dots, ar^{n-1}, ar^n$$

Use of recurrence relations\*  
eg  $P_{n+1} = P_n(1+r)$

\*You should understand and be able to use recurrence relations in a range of financial situations, such as iteratively calculating the balance on a credit card, the balance remaining on an outstanding mortgage loan, the accumulating amount in a savings account when you make regular savings and so on.

Continuous compounding

understanding that the idea of continuous compounding leads to exponential functions

ie

considering the case where

where  $P = P_0 \left(1 + \frac{r}{n}\right)^{nt}$  is the

amount after  $t$  years for an initial investment of  $P_0$  when the interest is compounded  $n$  times per year, and  $n \rightarrow \infty$

giving  $P = P_0 e^{rt}$

APR

(annual percentage rate)

Assume no arrangement or exit fees.

Use of the simplified version formula for APR in straightforward cases. ie

$$C = \sum_{k=1}^m \left( \frac{A_k}{(1+i)^{t_k}} \right)$$

where  $i$  is the APR expressed as a decimal,  $k$  is the number identifying a particular instalment,  $A_k$  is the amount of the instalment  $k$ ,  $t_k$  is the interval in years between the payment of the instalment and the start of the loan.

For simple cases only:

for example,

(i) for a single loan repaid in full after a fixed period in which

case  $C = \frac{A}{(1+i)^n}$  where  $n$  is the

number of years between the advance of the loan and its repayment.

(ii) for a loan repaid in a small number of instalments (eg 2, 3 or 4).

ie working with an equation of the form  $C =$

$$\frac{A_1}{1+i} + \frac{A_2}{(1+i)^2} + \frac{A_3}{(1+i)^3} + \frac{A_4}{(1+i)^4}$$

In this case you will be expected to either

- substitute values into the resulting equation for confirmation, or
- solve for  $i$  using the interval bisection method.

Applications to financial areas such as:

- loans
- credit cards
- mortgages
- savings

Personal Taxation

Complex calculations  
involving multiple rates

To include income tax,  
national insurance and value  
added tax. Capital gains tax,  
including the effect of  
indexation on the taxable  
gain.

## Indices used to measure key financial information

When you make a financial decision you need to have measures available that allow you to make sense of data. For example, as you found in section 1 when considering how the value of money varies over time, it is useful, if you are considering borrowing money and investigating which loan you should take that you make sure you have details of the APR

(annual percentage rate) for each possibility so that you can compare like with like. In this section you will learn how indices such as the retail price index and the FTSE 100 share index are developed so that you can quickly understand financial information such as how the cost of living is varying or how share prices are increasing or decreasing.

### What you need to learn

#### Financial aspect

Understanding of an index as a ratio that describes the relative change in a variable (e.g. price) compared to a certain base period (e.g. one specific year). As applied in particular to measures of inflation such as the Retail Price Index (RPI), Consumer Price Index (CPI) and Average Earning Index.

Calculating contributions made by individual items to indices, e.g. calculating contributions made by the prices of commodities in different shops and regions to a consumer price index.

#### Mathematical understanding

The index at any time tells you what percentage the variable is of its respective value at the base time. The value of the index at the base time is 100.

Weighted averages

#### This includes

Calculations using measures of inflation, including annual changes to pensions and tax allowances.

for example, carrying out calculations such as finding the effective costs of a commodity which varies in price between shops. Eg the commodity costs £5 in shop A and £6 in shop B. 0.4 of customers buy the commodity from shop A whereas 0.6 buy it from shop B. The effective cost of the commodity to be used in calculating an index is given by  $0.4 \times £5 + 0.6 \times £6 = £5.60$

understanding the idea of calculating a composite index by combining indices using weighting

e.g. in calculating a price index the index of each commodity multiplied by its weighting is totalled and this sum is divided by the sum of all the commodities weights.

calculating and using different index formulae

For the indices below the following apply:

$P_{it}$  is the price of commodity  $i$  at time  $t$

$Q_{it}$  is the quantity of commodity  $i$  at time  $t$

0 represents the base period so for example  $Q_{i0}$  represents the quantity of commodity  $i$  at the base period ( $t = 0$ )

Laspeyres index formula  
(weighted by quantities in the base period)

$$I_L = \left( \frac{\sum P_{it} Q_{i0}}{\sum P_{i0} Q_{i0}} \right) \times 100$$

Paasche index formula  
(weighted by quantities in the calculation period)

$$I_P = \left( \frac{\sum P_{it} Q_{it}}{\sum P_{i0} Q_{it}} \right) \times 100$$

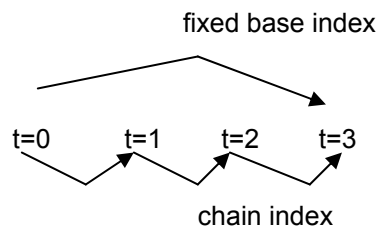
Fischer index formula

the geometric mean of the Laspeyres index formula and the Paasche index formula

$$I_F = \sqrt{I_L \times I_P}$$

using indices to understand change

understanding ideas of fixed base indices and chain indices



understanding that for a fixed-base index quantities at time t are compared with the base period ( t = 0 )

understanding that in a chain index comparisons are always made between subsequent points and therefore take account of changes between the start and end points.

percentage change

$$\frac{\text{current index} - \text{previous index}}{\text{previous index}} \times 100$$

calculating average changes

e.g. quarterly change figures from monthly figures

using the arithmetic mean

understanding and working with basic principles as well as applying to areas of finance such as:

- inflation including: consumer price index, retail price index
- FTSE 100 share index

## Making sense of data over time

Data you may want to use to make financial decisions is often presented as time-series data, that is a particular measure is given every month, quarter or annually. Sometimes, particularly when the data fluctuates a lot, this may have been processed so that you can identify trends over time. For example,

share prices can fluctuate from day to day, as can the FTSE 100 share index. To understand the underlying trend over time it useful to average the data before considering this. Other issues you may need to consider include seasonal variation and cyclical patterns.

### What you need to learn

#### Financial aspect

Considering data, either primary or secondary (such as financial indices), over time. Interpreting trends. The types of data considered should relate to data or indicators likely to be met when making personal financial decisions: for example, prices of stocks and shares (including 100 share index), interest rates, exchange rates and so on.

To smooth short-term fluctuations, time-series data can be averaged so that longer-term trends can be identified. For example, indices such as the 100 share index can fluctuate from day-to-day, but over a month or two there may be a distinct trend. Seasonal and cyclical variations may also be more easily detected by such smoothing.

Understanding that the simple weighted average based on a relatively large number of data points can be considered to lag behind the trend of the data

#### Mathematical understanding

Time series data in unprocessed form and understanding variability and how this may be random, seasonal or cyclical in nature.

Representation graphically and identifying linear trends

Moving averages:

for data points  $p_1, p_2, \dots$  the simple moving average,  $x_m$  at interval  $m$  takes account of  $n$  data points

$$x_m = \frac{p_m + p_{m-1} + p_{m-2} + \dots + p_{m-(n-1)}}{n}$$

Calculating successive values of the simple moving average using

$$\bar{x}_{m+1} = \bar{x}_m - \frac{p_{m-(n-1)}}{n} + \frac{p_{m+1}}{n}$$

The problem of lag in moving averages can be addressed using weighting.

The linear weighted moving average (over  $n$  intervals) weights the current data with weight  $n$ , the previous day with weight  $(n-1)$  and so on.

$$x_m = \frac{np_m + (n-1)p_{m-1} + (n-2)p_{m-2} + \dots + p_{m-(n-1)}}{n + (n-1) + (n-2) + \dots + 2 + 1}$$

#### This includes

Inspection of data tables and graphs.

Data over different time intervals, for example daily, weekly, quarterly etc.

Finding linear equations to model data using gradient and intercept and algebraic substitution.

Interpretation of situations which may include seasonal and cyclical variations.

recognising the denominator as a triangular number with sum  $\frac{n(n+1)}{2}$

## Tables and diagrams of financial information

Much basic financial information is presented in as simple a form as possible, for example using indices such as the Retail Price Index and FTSE 100 index which you learned about in section 2. Other information is often quoted in tabular or diagrammatic form giving simplified data and measures so that you can quickly compare like with like.

You will have met such ideas in other walks of life; for example, you are probably aware of school performance tables and how attempts have been made to look for measures of “value added” in pupil performance rather than taking raw scores that don’t allow for the ability of pupils at entry to different schools.

In this section you will learn how to make sense of a range of information presented in tables and diagram relating to personal finance.

For example, you will learn to interpret information about how an investment might perform or how to compare financial products.

It is not the intention that you should learn specific financial measures other than those highlighted in previous sections but that you should be able to work with and interpret financial information presented in tables and diagrams when basic terms are defined.

### You need to learn:

- to be able to extract and understand data from tables and diagrams
- to work with the data carrying out calculations using basic mathematics, such as calculating with percentages,
- to interpret the original data and results of your calculations in terms of the financial situation

## 3.5 FSMQ Hypothesis Testing (9994)

	You should learn:	Including:
<b>Binomial Distribution</b>	• Multiplication law for probabilities of independent events	<ul style="list-style-type: none"> <li>• For independent events only</li> <li>• <math>\binom{n}{r} p^r q^{n-r}</math> notation</li> <li>• Use of normal distribution tables</li> </ul>
	• Addition law for probabilities of exclusive events	
	• Tree Diagram	
	• Binomial probabilities	
	• Normal approximations and the standard normal distribution.	
<b>Sampling</b>	• Sampling from a parent population	<ul style="list-style-type: none"> <li>• The knowledge that improving accuracy by removing bias and increasing sample size can cost both time and money</li> <li>• Confidence intervals</li> </ul>
	• Precision and sample size	
	• Distribution of the sample mean and sample proportion from a normal population	
<b>Hypothesis Testing</b>	• The null and alternative hypotheses	<ul style="list-style-type: none"> <li>• With reference to the binomial and normal distributions only.</li> <li>• Triangle test and pairs-difference test</li> <li>• Placebo and double-blind trials</li> </ul>
	• One-tail and two-tail tests	
	• Significance level and critical region	
	• Specific tests to include	
	Opinion Polls	
Food Tasting		
Clinical Trials		
<b>Non-Parametric Tests</b>	• The sign test	
	• The Mann-Whitney U test	

## 3.6 FSMQ Decision Mathematics (9997)

### What you need to learn

Throughout your work you need to develop a critical and questioning approach to your own use of decision mathematics diagrams and techniques and also learn how these can be used to draw conclusions and summarise findings.

You will carry out work that involves you in:

selecting appropriate data to use

drawing appropriate network(s)

carrying out an analysis using an algorithmic approach

drawing conclusions and summarising findings.

The key ideas that you will meet and some specific techniques that you need to be able to use are set out below.

### Using networks to model real world situations

You should be able to represent a situation so that some of the relationships are clarified by the use of appropriate networks.

In drawing networks you should consider and understand:

- terminology such as vertices, edges, edge weights, paths and cycles
- connectedness
- directed and undirected edges and graphs

You should:

- be able to store graphs as matrices e.g. adjacency/distance matrices
- understand the degree of a vertex and be aware of odd and even vertices

### Trees and spanning trees

You should understand that a tree is a connected graph with no cycles and that every connected graph contains at least one tree connecting all the vertices of the original graph.

#### In your study of trees you should:

#### This includes:

understand the idea of a minimum connector (a spanning tree of minimum length)

finding minimum connectors using Prim's and Kruskal's algorithms

You will be expected to apply these algorithms in graphical and, for Prim's algorithms, also in tabular form

understand when a situation requires a minimum spanning tree to be found

commenting on the appropriateness of a solution in its context

appreciate the relative advantages of Prim's and Kruskal's algorithms

## Shortest Paths

In developing ideas about shortest paths you will need to appreciate that problems of finding paths of minimum time and cost can both be considered to be shortest path problems.

### In developing ideas about shortest paths you should:

### This includes:

---

be able to apply Dijkstra's algorithm

- using a labelling technique to identify the shortest path
- commenting on the appropriateness of a solution in its context

## Route Inspection Problem

In developing ideas about route inspection you will need to appreciate the connection with the classical problem of finding an Eulerian trail.

### In developing ideas about route inspection you should:

### This includes:

---

understand the significance of odd vertices

problems with 0, 2 or 4 odd vertices

---

be able to apply the Chinese Postman algorithm

commenting on the appropriateness of a solution in its context

## Travelling Salesperson Problem

In developing ideas about the Travelling Salesperson Problem you will need to appreciate the connection with the classical problem of finding a Hamiltonian cycle.

### In developing ideas about the Travelling Salesperson Problem you should:

### This includes:

---

be able to determine upper bounds by using the nearest neighbour algorithm

converting a practical problem into the classical problem

---

be able to determine lower bounds

finding the length of a minimum spanning tree for a network formed by deleting a given node and then adding the two shortest distances to the given node.

---

appreciate when a solution is sufficiently good

- realising that a solution is not necessarily the best
- commenting on the appropriateness of a solution in its context

## Critical Path Analysis

In developing ideas about Critical Path Analysis you will need to understand both how to construct and how to interpret activity networks with vertices representing activities.

**In developing ideas about Critical Path Analysis you should:**      **This includes:**

---

be able to find earliest and latest times

using forward and reverse passes

---

be able to identify critical activities and find a critical path

the calculation of floats

---

know how to construct and interpret cascade diagrams

## Mathematical modelling

You should be able to apply mathematical modelling to situation relating to the topics covered in this module. You will need to interpret results in contexts.

## Using calculators and computers

The use of a standard scientific calculator is sufficient for this unit.

However, software for the construction of networks or for the carrying out of algorithms is available commercially.

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## 3.7 FSMQ Calculus (9998)

This qualification has been developed to allow you to demonstrate your ability to use

- differentiation
- integration
- differential equations

to analyse, make sense of and describe real world situations and to solve problems. You will also investigate the use of numerical methods to find gradients and evaluate integrals and compare these with analytic methods.

Before you start this qualification

**You must:**

**This includes:**

be able to use algebraic methods to rearrange and solve linear and quadratic equations

Solution of a quadratic equation by at least one of the following methods:

- use of a graphics calculator
- use of formula

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

(which must be memorised)

- completing the square

Solution by factorisation will be acceptable where the quadratic factorises.

have knowledge of basic functions and how geometric transformations can be applied to them using

being familiar with graphs and functions of:

- transformations by the vector

$$\begin{bmatrix} a \\ 0 \end{bmatrix} \text{ and by the vector } \begin{bmatrix} 0 \\ a \end{bmatrix}$$

- stretches of scale factor  $a$  with the invariant line  $x = 0$  and with the invariant line  $y = 0$

- powers of  $x$ ,  
e.g.  $y = kx^{-2}$ ;  $y = kx^{-1}$ ;  
 $y = kx^{\frac{1}{2}}$ ;  $y = kx^3$ ;  $y = kx^4$
- quadratics:  
 $y = ax^2 + bx + c$ ,  
 $y = (ax - b)(x - c)$
- trigonometric functions:  
 $y = A\sin(mx + c)$   
 $y = A\cos(mx + c)$
- exponential functions:  
 $y = ke^{mx}$   
( $m$  positive or negative)
- logarithmic functions:  
 $y = a\ln(bx)$

Using calculators and computers When carrying out calculations, you may find the use of a standard scientific calculator sufficient.

You should learn to use your calculator effectively and efficiently. This will include learning to use:

- memory facilities
- function facilities (e.g.  $e^x$ ,  $\sin(x)$ , ...)

It is important that you are also able to carry out certain calculations without using a calculator, using both written methods and 'mental' techniques.

Whenever you use a calculator you should record your working as well as the result.

Understanding and using differentiation

**You should learn to:**

**This includes:**

understand and calculate gradient at a point,  $a$ , on a function  $y = f(x)$  using the numerical approximation:

$$\text{gradient} \approx \frac{f(a+h) - f(a)}{h}$$

where  $h$  is small

understanding how to improve the calculation of gradient at a point by using a smaller interval,  $h$ .

understand and interpret gradients in terms of their physical significance

understand and use the correct units with which to measure gradients /rates of change

sketch graphs of gradient functions

- curves that you do not know as functions
- curves defined as functions

identify the key features of gradient functions in terms of the gradient of the original function

- zeros of gradient functions linking to local turning points

understand how  $\frac{f(x+h) - f(x)}{h}$  can be used to generate a gradient function

differentiate functions

- using notations  $\frac{dy}{dx}$  and  $f'(x)$
- polynomials
- trigonometric functions using radians
- exponential functions

Differentiate

- sums and differences of functions
- functions multiplied by a constant
- products of functions

Understanding and using integration

find the second derivatives of functions	using notations $\frac{d^2 y}{dx^2}$ and $f''(x)$
identify the key features of a second derivative	<ul style="list-style-type: none"> <li>linking positive values to increasing gradient</li> <li>linking negative values to decreasing gradient</li> <li>linking zero values to points of inflexion</li> </ul>
Applications of differentiation to gradients, maxima and minima and stationary points, increasing and decreasing functions	<ul style="list-style-type: none"> <li>Application to determining maxima and minima</li> <li>understanding the importance of the second derivative and its value at such points</li> <li>understanding that zero values of the second derivative can occur at maximum and minimum points as well as points of inflexion</li> </ul>
<b>You should learn to:</b>	<b>This includes:</b>
estimate areas under graphs of functions using numerical methods	<ul style="list-style-type: none"> <li>the trapezium rule</li> <li>understanding how to improve your calculation of the area under a graph by using a smaller interval.</li> </ul>
understand and find areas under curves, between $x = a$ and $x = b$ using $\int_a^b f(x)dx$ , ( $f(x) \geq 0$ )	
understand integration as the reverse process of differentiation	
understand and determine indefinite integrals of functions	<ul style="list-style-type: none"> <li><math>x^n</math> (including <math>n = -1</math> and fractional)</li> <li><math>A \sin(mx + c)</math></li> <li><math>A \cos(mx + c)</math></li> <li><math>k e^{mx}</math> (<math>m</math> positive or negative)</li> <li>sums, differences and constant multiples of these using a constant of integration</li> </ul>

<p>Integration by inspection and</p> <p>by one use of integration by parts</p>	<ul style="list-style-type: none"> <li>eg: <math>\int e^{-5x} dx</math>, <math>\int \sin 6x dx</math></li> <li>eg: <math>\int xe^{-5x} dx</math>, <math>\int x \cos 4x dx</math>, <math>\int x \ln x dx</math></li> </ul>	
<p>understand the idea of constant of integration and be able to calculate this in known situations</p>		
<p>be able to determine definite integrals for functions</p>	<ul style="list-style-type: none"> <li>those functions defined above</li> </ul>	
<p>Understanding and using differential equations</p>	<p><b>You should learn to:</b></p>	<p><b>This includes:</b></p>
	<p>find families of solutions to first order differential equations with separable variables</p>	<ul style="list-style-type: none"> <li>find particular solutions when boundary conditions are given</li> </ul>

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## 3.8 Mathematical Applications (USE2)

Before you start this qualification

You must:

Have completed or be following courses for two of the following units:

Algebra USE1

Hypothesis Testing 9994

Data Analysis 9993

Decision Mathematics 9997

Dynamics 9995

Calculus 9998

Mathematical Principles for Personal Finance 9996

Portfolio requirements

Candidates are required to produce two pieces of work in their Coursework Portfolios.

- Each piece must be one coherent task with a consistent theme.
- The two pieces must be based upon the work of two different units from the above list. There can be some overlap between the two pieces but what is outside the overlap must be significant.
- Work going beyond that of a specific unit is, of course, acceptable but each piece can score full marks without the candidate working beyond the specification.
- A substantial proportion of the work for each piece must be on work beyond Higher Level GCSE Mathematics.

Assessing the Coursework Portfolio

The two tasks must be marked separately (using the same grid) and the two marks totalled to produce one final mark for the unit.

For each of the two tasks, the candidate will be given a mark, from 0 to 7, for each of three themes:

- Structuring and presenting work
- Using appropriate mathematics (and technology) and working accurately
- Interpreting mathematics

The marking grid gives a description under each of these themes for work at various marks.

	<b><i>Structuring and presenting work</i></b>	<b><i>Using appropriate mathematics (and technology) and working accurately</i></b>	<b><i>Interpreting mathematics</i></b>
<b>0</b>	The portfolio task has substantial omissions and is poorly presented.	There is little evidence of using mathematics accurately at the appropriate level.	There is little evidence of relating mathematics to the situation(s) investigated or there are substantial errors in interpretation.
<b>1</b>			
<b>2</b>	The portfolio task has been completed with only a little advice and is well presented so that it is easy to follow.	A significant proportion of the work is beyond GCSE and is substantially correct.	The candidate has interpreted the main mathematical findings in terms of the situation(s) investigated.
<b>3</b>			
<b>4</b>	The candidate has worked independently <i>and</i> produced a portfolio task that is well-structured and reported with clarity.	A significant proportion of the work is beyond Higher Level GCSE and is substantially correct, using relevant mathematical techniques <i>and</i> ICT where appropriate	The candidate has used mathematics to correctly summarise and draw conclusions about the situation(s) investigated.
<b>5</b>			
<b>6</b>	The candidate has shown initiative in developing their portfolio task <i>and</i> has structured it logically and has reported their work fluently.	The candidate has used appropriate, efficient and concise methods of working.	The candidate has considered, how their initial data, and assumptions where appropriate, affect their findings.
<b>7</b>			

Evidence to Support the Award of Marks

Portfolios must be presented in a clear and helpful way for the moderator. An indication must also be given at the appropriate point in the work, or in accompanying information, of any further guidance given by the teacher (or other person) which has significant assessment implications.

When the assessment of the portfolio is complete, the mark awarded for each theme and the total mark awarded must be entered on the Candidate Record Form, with supporting information given in the spaces provided.

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## 3.9 Mathematical Comprehension (USE3)

In their study of this unit candidates will build on the mathematical knowledge, skills and understanding they develop in working towards the compulsory units *Algebra* (studied as part of AS Use of Mathematics) and FSMQ *Calculus*. This unit can be studied alongside these other units.

In particular, this assessment will concentrate on:

- reading and making sense of the mathematics of other people
- the processes involved when mathematics is used to solve problems  
developing clarity in the communication of mathematics

### Written Examination

The comprehension paper will be one and a half hours in duration. It encourages candidates to communicate their results, working and reasoning clearly by allowing time for them to present their solutions with care.

The paper will have 45 marks allocated in the ratio 2:1 between sections A and B. The questions of Section A will be based in contexts using data from a Data Sheet that will be made available to candidates up to 14 days, and at least 7 days, prior to the examination. Candidates will be expected to familiarise themselves with the contexts outlined in the Data Sheet and should discuss these with others, including teachers.

Section B will require candidates to read a brief unseen article, describing the application of mathematical principles in context, upon which a number of questions will be based.

Both sections will include questions that test the mathematical principles developed in the AS unit *Algebra* and the FSMQ unit *Calculus* together with the mathematical processes and principles set out later in section 3.9.

Candidates will be required to answer all questions.

The use of a graphics calculator will be expected.

Candidates will be expected to remember all appropriate formulae as no formulae sheet will be provided.

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### Prior learning

This unit extends and develops the mathematics of the *Algebra* and *Calculus* units. You are therefore expected to be familiar with the content as outlined in their specifications. It is possible to study for this unit either alongside one or both of these units or to complete your studies for them prior to starting study of this unit.

**You should be able to use a graphics calculator to:**      **This includes:**

plot graphs of paired variable data

plot graphs of functions

use function facilities       $e^x$ ,  $\sin x$ , etc.

trace graphs                      finding intersections of functions with other functions and axes

use zoom facilities (if possible)                      finding significant features of functions such as turning points

You should be able to sketch graphs you have plotted with your graphics calculator showing clearly all significant features such as intercepts with axes, turning points and asymptotes.

**What you need to Learn**

This unit emphasises ‘process’ skills – the skills you need to develop to understand mathematical models of real situations.

These skills are identified and described in the five learning objectives below.

**Learning Objectives**

The five Learning Objectives define the skills, techniques and understanding that you need to develop during your study of this unit.

You will learn to:

- LO1** understand how mathematics can be used to model different situations
- LO2** extend, develop and use a range of knowledge, skills and understanding in the areas of algebra, graphs and calculus when modelling situations
- LO3** appreciate that general mathematical principles may be applicable in a range of different contexts
- LO4** make sense of mathematics
- LO5** work accurately, structure mathematical arguments carefully and communicate mathematics clearly

LO1 Understanding how mathematics can be used to model different situations

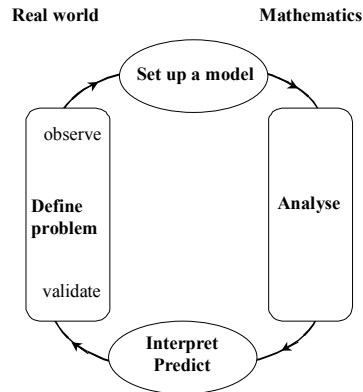
Throughout the course leading to this qualification you will use mathematical models of a range of real life contexts. It is important that you appreciate how these models relate to the situation and are aware of their limitations.

**You should:**

**Notes / Examples**

**L01a** appreciate the main stages involved in developing a mathematical model of a real situation

you may find a diagram useful in assisting your understanding of the stages of the process  
*for example:*



**L01b** understand that simplifying assumptions will be made when a mathematical model is developed and that these may introduce limitations into the usefulness of the model

*for example:* when modelling the growth of savings in a bank account a simplifying assumption may be that interest is added twice a year. In fact interest is often calculated daily, which can have the effect of increasing or decreasing the amount of interest added to the account over a period

when using numerical integration methods, such as the trapezium rule, you effectively assume that the variable follows a mathematical rule between the known data points (for example, a linear rule in the case of the trapezium rule). Consequently this can lead to an under or over estimate of the true value.

**L01c** be able to interpret the main features of mathematical models in terms of the real situations which they model and use these models to predict what will happen in situations for which you have no data

*for example:*

- when using direct proportion to model the relationship between two variables understand that when one variable is zero so is the other
- when using a function to model a situation you may use it to predict long term behaviour - perhaps by using linear extrapolation
- when using a differential equation to model a situation you can find the rate of change of one variable with respect to another without having access to data about this.

**L01d** consider the validity of mathematical models

*for example:*

by considering the predicted behaviour in extreme ( $t \rightarrow \infty$ ) or simple ( $t = 0$ ) cases

L01e appreciate that a general mathematical model allows you to solve a variety of related problems

for example:

the model  $a = Bc^t$  gives the rate of radioactive decay of all radioactive substances where the coefficients  $B$  and  $c$  depend on the substance

a situation that can be modelled by a

differential equation of the form  $\frac{dy}{dt} = ky$  has a

general solution  $y = Ae^{kt}$  and consequently exhibits features of exponential growth or decay.

L02 Extending, developing and using a range of numerical, algebraic, graphical and calculus techniques when modelling situations

L02a **You should learn to:**

appreciate when algebraic, graphical, numerical or calculus techniques (or combinations of these) are most appropriate, when they are inappropriate and when possibly unsound

establish links between different ways of understanding mathematical ideas

**Notes/Examples**

for example

- when finding the solutions of  $t^2 - t - 6 = 0$  the algebraic method of factorising, i.e.  $t^2 - t - 6 = (t - 3)(t + 2) = 0$   
 $\Rightarrow t = 3$  or  $t = -2$  is efficient and accurate giving all the solutions
- when finding distance travelled by computing the area under a linear speed-time graph calculating the area of a trapezium is appropriate and efficient, negating the use of more complicated methods involving calculus.
- you may use a graphics calculator and its trace facility to determine where  $t^3 - t + 1 = 0$ .  
You will not be able to solve this algebraically and should be aware that any solution of this equation found using a graphics calculator is not exact
- you should avoid looking for solutions to equations by substituting numerical values
- you should be aware that substitution is a valid method of checking the validity of a solution
- you should be aware that finding the gradient at many distinct points on a function allows you to plot a graph of the "gradient function" and you should understand how this is related to the

first derivative of the function and what this informs you about the context that the function models.

- you should be aware that the gradient at a single point on a function can be estimated by calculating the gradient of a line segment between this point and another close to it and how this might inform “differentiation from first principles”.

**L02b** **find** solutions to equations

**show** that particular solutions to equations are valid

know when each of these methods is appropriate

you should be able to:

- use algebraic and calculus methods and techniques to **find** solutions
- substitute numerical values or algebraic expressions into equations to **show** or **verify** that solutions are valid
- use graphs to visualise solutions

**L02c** use algebra to solve systems of:

- two linear equations
- one linear and one quadratic equation

you should:

- be aware that in general a system of  $n$  equations is needed to find  $n$  unknowns
- have a graphical understanding of when systems of equations have:
  - one or more solutions
  - no unique solution
  - no solution
- understand that every equation in a system of equations is satisfied simultaneously by each solution
- substitute solutions you find into all equations to check their validity

**L02d** be able to solve linear inequalities

you should be able to:

- substitute numerical values into linear expressions to determine whether or not inequalities hold
- solve equations algebraically to assist in the solution of inequalities
- present your solutions graphically:
  - using dashed lines to indicate boundaries not included
  - using full lines to indicate boundaries included
  - using shading to indicate regions not included

**L02e** use algebraic, graphical and calculus techniques to investigate continuous models in a wide variety of contexts such as population modelling, drug absorption, traffic flow and so on.

This includes the use of any of the functions specified in the AS unit *Algebra* and any of the methods and techniques specified in this unit and in the FSMQ *Calculus*.

**L03** Appreciating that general mathematical principles may be applicable in a range of different contexts

If you are to appreciate the power of mathematics as a tool that can be used to analyse a wide range of different situations, you need to be able to extract and appreciate general mathematical principles that underpin the work that you have been doing.

**You should learn to:**

**Notes/Examples**

**L03a** be able to identify the use of particular ideas in mathematics across a range of situations or contexts

you should aim to be able to transfer your use of mathematics into your work in other areas, *for example* you should:

- be familiar with using a range of different notations for common mathematical models (e.g.  $s = t^2 + 2t + 1$ ,  $g(c) = (c + 1)^2$ ,  $N = m(m + 1)$  are all quadratic functions and have the usual properties of such functions)
- understand that numerical and analytic methods of integration can be used to find the area under the graph of a function and that in some situations this may have physical significance.
- able to use algebraic and graphical models of direct proportion in different situations such as problems involving motion at constant speed (uniform motion) and those involving scaling lengths in plans and maps and be able to recognise the principles that underpin and are applicable in both situations
- able to identify the use of quadratic models in a range of situations using different notations such as those above and then be able to use mathematical methods to assist your analysis of these situations

- aware that differentiating any continuous function (eg quadratic, trigonometric, exponential and combinations of these) gives information about the rate of change of a variable
- aware of how the nature of the second derivative of a function can be used to inform you of the nature of significant features (such as turning points) of the original function.

L03b understand when mathematical methods will lead to solutions

*for example:*

- when you have three unknowns that you want to find, you need to have three equations involving these three unknowns
- being aware of when it will be possible to integrate a function using analytical techniques or whether you will need to resort to numerical techniques
- appreciating that when you have a general solution to a differential equation you will be able to find a particular solution if you know boundary conditions.
- understanding the problems that discontinuities in functions pose for calculus methods.

L03c have an appreciation of general features of graphs of functions, including intercepts with axes and asymptotes

including understanding:

- that the values of  $x$  where the graph of  $y = f(x)$  crosses the  $x$ -axis are solutions of the equation  $f(x) = 0$
- the  $x$ -coordinates of the points of intersection of the graphs  $y = f(x)$  and  $y = g(x)$  are solutions of the equation  $f(x) = g(x)$
- that when  $f(t)$  is continuous and  $f(a)$  is of a different sign to  $f(b)$  there is at least one solution of the equation  $f(t) = 0$  between  $t = a$  and  $t = b$
- of maximum and minimum points and points of inflexion, and being able to interpret these in terms of the situation that the function models.
- the nature of discontinuities in functions of the form  $f(x) = \frac{k}{x}$ ,  $g(x) = \frac{k}{x - a}$
- limiting values of functions of the form  $P(t) = Ae^{kt}$ ,  $g(x) = K - Ae^{kx}$

- the nature of horizontal asymptotes
- that vertical asymptotes may be incorrectly displayed by graphics calculators
- of how first and second derivatives of a function can inform you about important characteristics of key features of functions (eg whether a turning point is a maximum or minimum).

**L03d** develop your understanding of how geometric transformations can be applied to the graphs of basic functions and be able to use these when working with graphs that model real situations

including:

- the transformations of graphs of  $y = f(x)$  as defined in the AS unit *Algebra*
- having an appreciation of the symmetries of functions such as quadratic and trigonometric functions and being able to use such properties when working with models based on such functions

## L04 Making sense of mathematics

Making sense of mathematics is an important skill to develop since at some stage in your studies or future work you can expect that you may need to do this in a range of situations. When you come to explore the mathematics developed by someone else, particularly in workplace situations, you may find that it looks unfamiliar. Although the work will often be based on the same mathematical principles that you know, the context or setting of the mathematics and perhaps its development over time may result in it looking different.

### You should:

### Notes / Examples

**L04a** learn to explain steps in mathematical working by developing sub-steps if necessary

*for example*, you should be able to set out the mathematical working that explains the statement:

**L04b** learn to relate mathematics in new situations to mathematics in situations with which you are familiar

*for example*, when calculating the possible percentage error due to rounding to the nearest year in a population model such as  $P = Ae^{kt}$ , you may relate this to earlier experience of calculating percentage errors in finding the area of a rectangle when you rounded lengths to the nearest centimetre

**L04c** develop strategies to assist you in making sense of mathematics

*for example*, this could involve you in considering:

- extremes (eg in modelling a population using  $P = 100 - 30 \times 0.8^t$ , considering what happens as  $t \rightarrow \infty$ )
- boundary conditions (e.g. when  $t = 0$  the initial population predicted by the model  $P = 100 - 30 \times 0.8^t$  is  $P = 100 - 30 = 70$ )
- simple values (e.g. a financial measure 'debtor days' is given by

$$\frac{\text{outstanding debt}}{\text{annual turnover}} \times 365$$

- you may make sense of this by substituting 'simple' values of 1 million for outstanding debt and 2 million for annual turnover

a situation that can be modelled by a function  $y = f(t)$  for  $t > 0$ , such that  $f'(t) = t^2$  is such that the gradient is always positive and consequently the function is always increasing.

L05 Working accurately, structuring mathematical arguments carefully and communicating mathematics clearly

When applying mathematics to analyse a situation or solve a problem you will need to work accurately and structure your work carefully. You should aim to present your mathematics so that the logic of your thinking and argument can be followed easily by others.

	<b>You should learn to:</b>	<b>Notes / Examples</b>
L05a	identify possible errors in your working by: <ul style="list-style-type: none"> <li>• questioning whether your solutions are reasonable and / or valid</li> <li>• using checking techniques wherever possible</li> </ul>	<i>For example:</i> <ul style="list-style-type: none"> <li>• you could consider the magnitude of solutions (e.g. when modelling population growth of a country if you calculate that the population will increase ten-fold in ten years consider whether this is reasonable)</li> <li>• you could consider the dimensions of values you are calculating (e.g. <math>k \times l \times h</math> has the dimensions of area if <math>k</math> is a dimensionless constant and both <math>l</math> and <math>h</math> are lengths)</li> <li>• if you have used definite integration to calculate the area under the graph of a function and the resulting value is negative, but it is clear from inspection of the graph that the area is positive you should be aware that you have made an error.</li> <li>• if you have found solutions to simultaneous equations check that these are correct by substituting the values you have found back into the equations</li> <li>• using differentiation to check your solution to an indefinite integral</li> </ul>

L05b decide on the appropriate degree of accuracy of values you calculate

for example:

- when using a calculator to find the area of a circle of radius 10 cm (correct to the nearest cm) your calculator will use  $\pi = 3.14159265$ . You should not quote your final answer to the accuracy of the value on your calculator display
- when using values read from graphs think carefully about the accuracy of any values that you subsequently calculate

L05c ensure that you

- write clear and unambiguous mathematical statements

this includes correct use of brackets

your mathematics should read correctly (as an English sentence), e.g. when solving

$$10t - 5t^2 = 0 \text{ write:}$$

$$5t(2-t) = 0 \Rightarrow t = 0 \text{ or } t = 2$$

$$\text{NOT: } 10t - 5t^2 = 5t(2-t) = 0,2$$

- include the constant of integration, e.g.

$$\begin{aligned} s &= \int u - gt \, dt \\ &= ut - \frac{gt^2}{2} + c \end{aligned}$$

subsequently you may establish the value of  $c$  by substituting known values into the solution.

- use notation correctly

notation you use should include:

- therefore,  $\therefore$
- equals,  $=$
- approximately equals,  $\approx$
- inequalities,  $<$ ,  $>$ ,  $\leq$ ,  $\geq$
- implies,  $\Rightarrow$

L05d use algebraic, graphical, numerical and calculus techniques effectively to communicate your mathematics

for example:

when working with a population that may be modelled by the function

$$P = 100 - 30 \times 0.8^t \text{ you could:}$$

- most effectively show how this varies with time by plotting or sketching a graph of  $P$  against  $t$ .



- explore the long term behaviour predicted by this population model by substituting a large value for  $t$  and note that  $P$  is approximately 100
- when exploring how the length of daylight hours varies throughout the year you might differentiate a function used to model this (such as

$$T = 12 - 4\cos\left(\frac{n\pi}{180}\right), \text{ where } T \text{ is}$$

the number of daylight hours,  $n$  is the number of days after January 1st) to show how the rate of change will be a

maximum when  $\frac{d^2T}{dn^2}$ , that is when

$$\frac{\pi^2}{45 \times 180} \cos\left(\frac{n\pi}{180}\right) = 0, \text{ and therefore}$$

$n = 90$  and  $n = 270$ . Interpreting this in terms of the situation implies that 90 and 270 days after January 1<sup>st</sup> the rate of change of daylight hours is a maximum (sunrise and sunset are getting further apart most quickly).

# 4 Scheme of Assessment

## 4.1 Aims

AS and A-level courses based on this specification should enable candidates to:

- study a mathematics curriculum that is integrated with other areas of their study, work or interest leading to the application of mathematics in these areas
- develop skills in the communication, use and interpretation of their mathematics
- solve substantial and realistic problems encountered by adults
- solve open-ended problems
- develop mathematical modelling and reasoning skills
- use ICT as an exploratory tool for developing mathematical

understanding and when solving problems

- enjoy mathematics and develop confidence in using mathematics

In addition, the A-level specification in Use of Mathematics should enable candidates to:

- demonstrate skills in mathematical communication, including the comprehension of models in context and mathematical writing and argument
- explore and consolidate mathematical techniques through investigation and application

## 4.2 Assessment Objectives (AOs)

The Assessment Objectives are common to both AS and A-level, although their weighting differs. All candidates will be required to demonstrate work to satisfy the following Assessment Objectives in the context of the content and skills prescribed.

Examinations in Use of Mathematics will assess a candidate's ability to apply mathematical principles to analyse and make sense of situations, to solve problems and to draw conclusions. Candidates should be able to develop and use mathematics as a model of reality and have an awareness of any limitations this may introduce into their analysis of a situation.

In particular, the examinations will assess the following objectives in the context of the content and skills set out in Section 3 (Subject Content).

- AO1 select and organise data in a form that allows ease of analysis

- AO2 select, recall and use mathematics appropriate to the situation, giving solutions to an appropriate degree of accuracy

- AO3 interpret what their mathematics tells them about the situation they are analysing or the problem they are solving, using this information to summarise and draw conclusions

- AO4 communicate clearly using logical reasoning and appropriate notation

- AO5 select when it is and when it is not appropriate to use ICT or other permitted resources (such as formulae booklets or statistical tables) and be able to work competently with such resources

The assessment objectives apply to the whole specification.

## Quality of Written Communication

GCE specifications which require candidates to produce written material in English must:

- ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
- select and use a form and style of writing appropriate to purpose and to complex subject matter;
- organise information clearly and coherently, using specialist vocabulary where appropriate.

In this specification, QWC will be assessed in the unit USE2 Mathematical Applications within theme 1 of the marking grid, structuring and presenting work, and in the unit USE3 Mathematical Comprehension, where marks are awarded for the use of notation and argument under learning objective LO5c.

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## 4.3 Weighting of Assessment Objectives for AS

The approximate relationship between the relative percentage weighting of the Assessment Objectives (AOs) and the overall scheme of assessment is shown in the following table.

Assessment Objectives	Unit Weighting (%)			Overall Weighting of AOs (%)
	Algebra	FSMQ Option	FSMQ Option	
AO1	3–6	3–6	3–6	9–18
AO2	13–20	13–20	13–20	39–60
AO3	3–6	3–6	3–6	9–18
AO4	3–6	3–6	3–6	9–18
AO5	0–6	0–6	0–6	0–18
Overall weighting of units (%)	$33\frac{1}{3}$	$33\frac{1}{3}$	$33\frac{1}{3}$	100

## 4.4 Weighting of Assessment Objectives for A Level

The table below shows the approximate weighting of each of the Assessment Objectives in the AS and A2 Units.

Assessment Objectives	Unit Weighting (%)						Overall Weighting Of AOs (%)
	Algebra	FSMQ Option	FSMQ Option	Calculus	Mathematical Applications	Mathematical Comprehension	
AO1	$1\frac{1}{2} - 3$	$1\frac{1}{2} - 3$	$1\frac{1}{2} - 3$	$1\frac{1}{2} - 3$	2 – 4	2 – 4	10 – 20
AO2	$6\frac{1}{2} - 10$	$6\frac{1}{2} - 10$	$6\frac{1}{2} - 10$	8 – 11	2 – 4	$7\frac{1}{2} - 10$	37 – 55
AO3	$1\frac{1}{2} - 3$	$1\frac{1}{2} - 3$	$1\frac{1}{2} - 3$	$1\frac{1}{2} - 3$	2 – 4	2 – 4	10 – 20
AO4	$1\frac{1}{2} - 3$	$1\frac{1}{2} - 3$	$1\frac{1}{2} - 3$	$1\frac{1}{2} - 3$	2 – 4	2 – 4	10 – 20
AO5	0 – 3	0 – 3	0 – 3	0 – 3	3 – 6	0 – 4	3 – 22
Overall weighting of units (%)	$16\frac{2}{3}$	$16\frac{2}{3}$	$16\frac{2}{3}$	$16\frac{2}{3}$	$16\frac{2}{3}$	$16\frac{2}{3}$	100

## 4.5 National Criteria

This specification complies with the following.

- The Code of Practice for GCE
- The GCE AS and A level Qualification Criteria
- The Arrangements for the Statutory Regulation of External Qualifications in England, Wales

and Northern Ireland: Common Criteria

## 4.6 Prior learning

Mathematics is, inherently, a sequential subject. There is a progression of material through all levels at which the subject is studied. This specification builds on the knowledge, understanding and skills associated with GCSE Mathematics, GCSE Use of Mathematics and the Intermediate level FSMQs. However, there is no specific requirement in terms of tier of GCSE entry or grade achieved.

Any requirements set for entry to a course following this specification are at the discretion of centres.

There are also additional prior learning requirements for several of the individual component units of AS and A-level Use of Mathematics. These are listed at the beginning of the subject content outline for each unit in section 3 of this specification.

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## 4.7 Synoptic Assessment and Stretch and Challenge

Use of Mathematics is synoptically assessed at A2 level by two compulsory units. The portfolio submitted for Mathematical Applications (USE2) is based on the content of two different constituent units of the A-level. Unit USE3, Mathematical Comprehension, requires candidates to understand and use mathematical writing derived from the content of the Algebra and Calculus units.

The requirement that stretch and challenge be included at A2 is met by the unit Mathematical Applications (USE2), where candidates employ and explore the techniques they have learned in greater depth.

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## 4.8 Pre-release data sheets

All written examinations will involve a pre-release data sheet.

Data sheets should be opened and issued to candidates between 1 and 3 weeks before the examination. Candidates will be able to work with their teachers in familiarising themselves with the contexts, clarifying any specialised vocabulary and considering the possible mathematics in the situation presented. Teachers will need to provide reasonable class time for this to happen. This should be at least one lesson but there is no upper limit on the time candidates can spend considering the data sheet (provided, of course, they remain

sealed until the date for release printed on the packet label).

The pre-release data sheet must not be taken into the examination room. A clean copy of the data along with any further data required for the other questions will be issued to all candidates at the start of the examination. This sheet will not be collected in and marked so candidates should ensure that all working is presented in the question paper/answer book.

(Please note that if you teach any non-pilot FSMQ or Use of Maths units, the data sheets should still only be opened and issued 1 to 2 weeks before the examination.)

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## 4.9 Formulae and Statistical Tables

Candidates sitting Data Analysis (9993) or Hypothesis Testing (9994) will now each require a formula book during the examination. There will not be a booklet of formulae and statistical tables inside the question paper as an insert. These formula books will be available prior to the examination. The FSMQ/Use of Maths formula book is purple (like the pilot exam paper covers) and is not the blue A-Level Maths formula book.

Please note that these must be ordered through the subject office and will not be despatched automatically.

The booklet will be the same year on year and will contain any formulae which candidates are expected to be able to use but are not required to memorise.

## 5 Administration

### 5.1 Availability of Assessment Units

	<b>June 2009</b>
AS Use of Mathematics 9361	✓
A level Use of Mathematics 9362	✓
Algebra USE1	✓
FSMQ Data Analysis 9993	✓
FSMQ Hypothesis Testing 9994	✓
FSMQ Dynamics 9995	✓
FSMQ Mathematical Principles for Personal Finance 9996	✓
FSMQ Decision Mathematics 9997	✓
FSMQ Calculus 9998	✓
Mathematical Applications USE2	✓
Mathematical Comprehension USE3	✓

The continued availability of this specification will be reviewed after each year of the pilot. This specification is correct for 2009 only. It is expected to run with revisions until Summer 2010.

No units for AS or A level Use of Mathematics will be available in the January series during the pilot.

Units may be taken in any order.

Candidates are recommended to take the Mathematical Comprehension unit after studying the courses for Algebra and Calculus units, as it includes synoptic assessment of the content of these courses.

Similarly, candidate's portfolios for Mathematical Applications will be based on two other component units of Use of Mathematics and work will most naturally be produced alongside or after these courses.

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## 5.2 Entries

These pilot qualifications will not appear in the current version of *Entry Procedures and Codes*. You should use the indicated entry codes for these qualifications.

AS Certification – 9361

A Level Certification - 9362

FSMQ Data Analysis	9993
FSMQ Hypothesis Testing	9994
FSMQ Dynamics	9995
FSMQ Mathematical Principles for Personal Finance	9996
FSMQ Decision Mathematics	9997
FSMQ Calculus	9998
Algebra	USE1
Mathematical Applications	USE2
Mathematical Comprehension	USE3

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## 5.3 Private Candidates

This pilot specification is available to private candidates. Private candidates should write to AQA for a copy of *Supplementary Guidance for Private Candidates*.

Arrangements must be agreed with AQA for the assessment and authentication of coursework.

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## 5.4 Access arrangements and Special Consideration

We have taken note of the provisions of the Disability Discrimination Act (DDA) 1995 in developing and administering this specification.

We follow the guidelines in the Joint Council for Qualifications (JCQ) document: *Access Arrangements and Special Consideration: Regulations and Guidance Relating to Candidates who are Eligible for Adjustments in Examination GCE, AEA, GCSE, Entry Level & Key Skills*. This is published on the JCQ website ([http://www.jcq.org.uk/access\\_arrangements/](http://www.jcq.org.uk/access_arrangements/)) or you can follow the link from our website ([http://www.aqa.org.uk/admin/p\\_special\\_3.html](http://www.aqa.org.uk/admin/p_special_3.html)).

### Access Arrangements

We can make arrangements so that candidates with disabilities (under the terms of the DDA) can access the assessment. These arrangements must be made **before** the examination. For example, we can produce a Braille paper for a candidate with a visual impairment.

### Special Consideration

We can give special consideration to candidates who have had a temporary illness, injury or indisposition at the time of the examination. Where we do this, it is given **after** the examination.

Applications for access arrangements should be submitted to AQA by the Examinations Officer at the centre.

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## 5.5 Language of Examinations

We will provide the unit for this specification in English only.

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## 5.6 Qualification Titles

GCE qualifications based on this specification are:

- AQA Advanced Subsidiary Use of Mathematics
- AQA Advanced Level Use of Mathematics

Advanced FSMQ qualifications based on this specification are:

- AQA Advanced Level Free-Standing Mathematics Qualification: Data Analysis
- AQA Advanced Level Free-Standing Mathematics Qualification: Dynamics

- AQA Advanced Level Free-Standing Mathematics Qualification: Mathematical Principles for Personal Finance
- AQA Advanced Level Free-Standing Mathematics Qualification: Hypothesis Testing
- AQA Advanced Level Free-Standing Mathematics Qualification: Decision Mathematics
- AQA Advanced Level Free-Standing Mathematics Qualification: Calculus

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## 5.7 Awarding Grades and Reporting Results

In 2009, both the AS and the full A-level qualification will be awarded on a five-grade scale: A, B, C, D and E.

From 2010, the AS qualification will be awarded on a five-grade scale: A, B, C, D and E and the A-level qualification will be awarded on a six-grade scale: A\*, A, B, C, D and E.

To be awarded an A\*, candidates will need to achieve a grade A on the full A-level qualification and an A\* on the aggregation of the A2 units.

For AS and A-level, candidates who fail to reach the minimum standard for grade E will be recorded as U (unclassified) and will not receive a qualification certificate.

Individual Advanced FSMQ results will be certificated.

Advanced FSMQ qualifications will also be graded individually on the same five-grade scale, A to E. Candidates who fail to reach the minimum standard for grade E will be recorded as U (unclassified) and will not receive a qualification certificate.

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## 5.8 Re-Sits and Shelf-Life of Unit Results

Unit results remain available to count towards certification, whether or not they have already been used, for the length of the pilot.

Candidates may re-sit a unit any number of times during the pilot. The best result for each unit will count towards the final qualification. Candidates who wish to repeat a qualification may do so by re-taking one or more units. The appropriate subject award entry, as well as the unit entry/entries, must be submitted in order to be awarded a new subject grade.

Candidates will be graded on the basis of the work submitted for assessment.

## 6 Coursework Administration

The Head of Centre is responsible to AQA for ensuring that coursework/portfolio work is conducted in accordance with AQA's instructions and JCQ instructions.

### 6.1 Supervision and authentication of coursework

The Code of Practice for GCE requires:

- **candidates** to sign the Candidate Record Form (CRF) to confirm that the work submitted is their own, and
- **teachers/assessors** to confirm on the CRF that the work assessed is solely that of the candidate concerned and was conducted under the conditions laid down by the specification.

The completed CRF for each candidate must be attached to his/her work. All teachers who have assessed the work of any candidate entered for each component must sign the declaration of authentication. Failure to sign the authentication statement may delay the processing of the candidates' results.

The teacher should be sufficiently aware of the candidate's standard and level of work to appreciate if the coursework submitted is beyond the talents of the candidate.

In most centres teachers are familiar with candidates' work through class and homework assignments. Where this is not the case, teachers should make sure that coursework is completed under direct supervision.

In all cases, some direct supervision is necessary to ensure that the coursework

submitted can be confidently authenticated as the candidate's own.

If teachers/assessors have reservations about signing the authentication statements, the following points of guidance should be followed.

- If it is believed that a candidate has received additional assistance and this is acceptable within the guidelines for the relevant specification, the teacher/assessor should award a mark which represents the candidate's unaided achievement. The authentication statement should be signed and information given on the relevant form.
- If the teacher/assessor is unable to sign the authentication statement for a particular candidate, then the candidate's work cannot be accepted for assessment.
- If malpractice is suspected, the Examinations Officer should be consulted about the procedure to be followed.

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## 6.2 Malpractice

Teachers should inform candidates of the AQA Regulations concerning malpractice.

Candidates must **not**:

- submit work which is not their own;
- lend work to other candidates;
- allow other candidates access to, or the use of, their own independently-sourced source material;
- include work copied directly from books, the internet or other sources without acknowledgement or attribution;
- submit work typed or word-processed by a third person without acknowledgement.

These actions constitute malpractice, for which a penalty (eg disqualification from the examination) will be applied.

Where suspected malpractice in coursework/portfolios is identified by a centre after the candidate has signed the declaration of authentication, the Head of Centre must submit full details of the case to AQA at the earliest opportunity. The form JCQ/M1 should be used. Copies of the form can be found on the JCQ website (<http://www.jcq.org.uk/>).

Malpractice in coursework/portfolios discovered prior to the candidate signing the declaration of authentication need not be reported to AQA, but should be dealt with in accordance with the centre's internal procedures. Details of any work which is not the candidate's own must be recorded on the coursework/portfolio cover sheet or other appropriate place.

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## 6.3 Teacher Standardisation

We will hold annual standardising meetings for teachers for the portfolio unit. At these meetings we will provide support in developing appropriate coursework tasks and using the marking criteria. We will contact pilot centres to invite you to a meeting.

We will also contact centres to invite them to send a representative if

- the moderation of coursework/portfolio work from the previous year has identified a serious misinterpretation of the portfolio requirements,
- inappropriate tasks have been set, or
- a significant adjustment has been made to a centre's marks.

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## 6.4 Internal standardisation of marking

Centres must standardise marking within the centre to make sure that all candidates at the centre have been marked to the same standard. One person must be responsible for internal standardisation. This person should sign the Centre Declaration Sheet to confirm that internal standardisation has taken place.

Internal standardisation involves:

- all teachers marking some trial pieces of work and identifying differences in marking standards;
- discussing any differences in marking at a training meeting for all teachers involved in the assessment;
- referring to reference and archive material such as previous work or examples from AQA's teacher standardising meetings.

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## 6.5 Annotation of coursework

The Code of Practice for GCE states that the awarding body must require internal assessors to show clearly how the marks have been awarded in relation to the marking criteria defined in the specification and that the awarding body must provide guidance on how this is to be done.

The annotation will help the moderator to see as precisely as possible where the teacher considers that the candidates have met the criteria in the specification.

Work could be annotated by either of the following methods:

- key pieces of evidence flagged throughout the work by annotation either in the margin or in the text;
- summative comments on the work, referencing precise sections in the work.

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## 6.6 Submitting marks and sample work for moderation

The total mark for each candidate must be submitted to AQA and the moderator on the mark forms provided or by Electronic Data Interchange (EDI) by the specified date.

Centres will be informed which candidates' work is required in the samples to be submitted to the moderator.

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## 6.7 Factors affecting individual candidates

Teachers should be able to accommodate the occasional absence of candidates by ensuring that the opportunity is given for them to make up missed assessments.

If work is lost, AQA should be notified immediately of the date of the loss, how it occurred, and who was responsible for the loss. Centres should use the JCQ form JCQ/LCW to inform AQA Candidate Services of the circumstances.

Where special help which goes beyond normal learning support is given, AQA must be informed through comments on the CRF so that such help can be taken into account when moderation takes place.

Candidates who move from one centre to another during the course sometimes present a problem for a scheme of internal assessment. Possible courses of action depend on the stage at which the move takes place. If the move occurs early in the course the new centre should take responsibility for assessment. If it occurs late in the course it may be possible to arrange for the moderator to assess the work through the 'Educated Elsewhere' procedure. Centres should contact AQA at the earliest possible stage for advice about appropriate arrangements in individual cases.

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## 6.8 Retaining evidence and re-using marks

The centre must retain the work of all candidates, with CRFs attached, under secure conditions, from the time it is assessed, to allow for the possibility of an enquiry about results. The work may be

about a result has been made, the work must remain under secure conditions in case it is required by AQA.

returned to candidates after the deadline for enquiries about results. If an enquiry

# 7 Moderation

## 7.1 Moderation procedures

Moderation of the coursework is by inspection of a sample of candidates' work, sent by post from the centre to a moderator appointed by AQA. The centre marks must be submitted to AQA and to the moderator by the specified deadline. We will let centres know which candidates' work will be required in the sample to be submitted for moderation.

Following the re-marking of the sample work, the moderator's marks are compared with the centre marks to determine whether any adjustment is needed in order to bring the centre's assessments into line with

standards generally. In some cases it may be necessary for the moderator to call for the work of other candidates in the centre. In order to meet this possible request, centres must retain under secure conditions and have available the coursework and the CRF of every candidate entered for the examination and be prepared to submit it on demand. Mark adjustments will normally preserve the centre's order of merit, but where major discrepancies are found, we reserve the right to alter the order of merit.

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## 7.2 Post-moderation procedures

The candidates' work will be returned to the centre after the examination. The centre will receive a report giving feedback on the appropriateness of the tasks set, the

accuracy of the assessments made, and the reasons for any adjustments to the marks. We may retain some candidates' work for archive or standardising purposes.

# Appendices

## A Grade descriptions

The following grade descriptors indicate the level of attainment characteristic of the given grade at AS and A-level. They give a general indication of the required learning outcomes at each specific grade. The descriptors should be interpreted in relation to the content outlined in the specification; they are not designed to define that content.

The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives (as in Section 4.2) overall. Shortcomings in some aspects of the examination may be balanced by better performances in others.

### Grade A

Within the context of the Free-Standing Mathematics qualifications and other units studied, candidates demonstrate a good understanding and knowledge of the mathematical facts, concepts and techniques that are needed, and select appropriate ones to use in a wide variety of contexts, both familiar and unfamiliar.

Candidates manipulate mathematical expressions and use graphs, sketches, tables and diagrams, all with high accuracy and skill. They use mathematical language and symbols correctly and effectively in presenting a convincing reasoned argument. When confronted with unstructured problems, they can often devise and implement an effective solution strategy. If errors are made in their calculations or logic, these are sometimes noticed and corrected.

Candidates recall or recognize almost all the standard models that are needed, and select appropriate ones to represent a wide variety of situations in the real world. They correctly refer results from calculations using the model to the original situation; they give sensible interpretation of their results in the context of the original realistic situation. Their reports include mathematical justifications, explaining their solutions to problems involving a number of features or variables. They make intelligent comments on the modeling assumptions and suggest possible refinements to the model.

Candidates comprehend or understand the meaning of almost all translations into mathematics of common realistic contexts. They correctly refer the results of calculations back to the given context and usually make sensible comments or predictions. They can distil the essential mathematical information from extended pieces of prose having mathematical content. They can comment meaningfully on the mathematical information.

Candidates make appropriate and efficient use of contemporary calculator technology and other permitted resources, and are aware of any limitations to their use. They present results to an appropriate degree of accuracy.

### Grade C

Within the context of the Free-Standing Mathematics qualifications and other units studied, and starting from problems or contexts that have been presented to them, candidates refine or extend the mathematics used to generate fuller solutions. They recall or recognize most of the mathematical facts, concepts and techniques that are needed and usually select appropriate ones to use in a variety of contexts.

Candidates manipulate mathematical expressions and use graphs, sketches, tables and diagrams, all with a reasonable level of accuracy and skill. They use mathematical language and symbols with some skill and

sometimes proceed logically through extended arguments or proofs. When confronted with unstructured problems, they sometimes devise and implement an effective and efficient solution strategy. They occasionally notice and correct errors in their calculations.

Candidates recall or recognize most of the standard models that are needed, and usually select appropriate ones to represent a variety of situations in the real world. They often correctly refer results from calculations using the model to the original situation; they sometimes give sensible interpretation of their results in the context of the original realistic situation. They sometimes make intelligent comments on the modeling assumptions and suggest possible refinements to the model.

Candidates comprehend or understand the meaning of most translations into mathematics of common realistic contexts. They often correctly refer the results of calculations back to the given context and sometimes make sensible comments or predictions. They distil much of the essential mathematical information from extended pieces of prose having mathematical content. They give some useful comments on this mathematical information.

Candidates usually make appropriate and efficient use of contemporary calculator technology and other permitted resources, and are sometimes aware of any limitations to their use. They usually present results to an appropriate degree of accuracy.

## Grade E

Within the context of the Free-Standing Mathematics qualifications and other units studied, candidates identify necessary information in order to carry through tasks and solve mathematical problems. They recall or recognize some of the mathematical facts, concepts and techniques that are needed and sometimes select appropriate ones to use in some contexts.

Candidates manipulate mathematical expressions and use graphs, sketches, tables and diagrams, all with some accuracy and skill. They sometimes use mathematical language correctly and occasionally proceed logically through extended argument or proofs.

Candidates recall or recognize some of the standard models that are needed and sometimes select appropriate ones to represent a variety of situations in the real world. They sometimes correctly refer results from calculations using the model to the original situation; they try to interpret their results in the context of the original realistic situation.

Candidates sometimes comprehend or understand the meaning of translations in mathematics of common realistic contexts. They sometimes correctly refer the results of calculations back to the given context and attempt to give comments or predictions. They distil some of the essential mathematical information from extended pieces of prose having mathematical content. They attempt to comment on this mathematical information.

Candidates often make appropriate and efficient use of contemporary calculator technology and other permitted resources. They often present results to an appropriate degree of accuracy.

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## **B Key Skills - Teaching, Developing and Providing Opportunities for Generating Evidence**

### **Introduction**

The Key Skills Qualification requires candidates to demonstrate levels of achievement in the Key Skills of Communication, Application of Number and Information Technology.

The units for the 'wider' Key Skills of Improving own Learning and Performance, Working with Others and Problem Solving are also available. The acquisition and demonstration of ability in these 'wider' Key Skills is deemed highly desirable for all candidates, but they do not form part of the Key Skills Qualification.

Copies of the Key Skills Units may be downloaded from QCA's website (<http://www.qca.org.uk/keyskills>).

The units for each Key Skill comprise three sections:

- What you need to know.
- What you must do.
- Guidance.

Candidates following a course of study based on this specification for GCE Use of Mathematics can be offered opportunities to develop and generate evidence of attainment in aspects of the Key Skills of:

- Communication;
- Application of Number;
- Information Technology;
- Working with Others;
- Improving own Learning and Performance;
- Problem Solving.

Areas of study and learning that can be used to encourage the acquisition and use of Key Skills, and to provide opportunities to generate evidence for Part B of the units, are signposted in the table.

	Algebra	FSMQ Advanced: Data Analysis	FSMQ Advanced: Dynamics	FSMQ Advanced: Mathematical Principles for Personal Finance	FSMQ Advanced: Hypothesis Testing
<b>Communication</b>					
C3.1a	✓	✓	✓	✓	✓
C3.1b	✓	✓	✓	✓	✓
C3.2	✓	✓	✓	✓	✓
C3.3					
<b>Application of Number</b>					
N3.1	✓	✓	✓	✓	✓
N3.2a	✓	✓	✓	✓	✓
N3.2b	✓	✓	✓	✓	✓
N3.2c		✓		✓	✓
N3.2d	✓	✓	✓	✓	✓
N3.3	✓	✓	✓	✓	✓
<b>Information Technology</b>					
ICT3.1	✓	✓	✓	✓	✓
ICT3.2	✓	✓		✓	✓
ICT3.3					
<b>Working with Others</b>					
WO3.1	✓	✓	✓	✓	✓
WO3.2	✓	✓	✓	✓	✓
WO3.3	✓	✓	✓	✓	✓
<b>Improving Own Learning and Performance</b>					
LP3.1	✓	✓	✓	✓	✓
LP3.2	✓	✓	✓	✓	✓
LP3.3	✓	✓	✓	✓	✓
<b>Problem Solving</b>					
PS3.1	✓	✓	✓	✓	✓
PS3.2	✓	✓	✓	✓	✓
PS3.3	✓	✓	✓	✓	✓

	<b>FSMQ Advanced: Decision Mathematics</b>	<b>FSMQ Advanced: Calculus</b>	<b>Mathematical Applications</b>	<b>Mathematical Comprehension</b>
<b>Communication</b>				
C3.1a	✓	✓	✓	✓
C3.1b	✓	✓	✓	✓
C3.2	✓	✓	✓	✓
C3.3			✓	
<b>Application of Number</b>				
N3.1	✓	✓	✓	✓
N3.2a	✓	✓	✓	✓
N3.2b	✓	✓	✓	✓
N3.2c			✓	
N3.2d	✓	✓	✓	✓
N3.3	✓	✓	✓	✓
<b>Information Technology</b>				
ICT3.1	✓	✓	✓	✓
ICT3.2	✓	✓	✓	✓
ICT3.3	✓		✓	
<b>Working with Others</b>				
WO3.1	✓	✓	✓	✓
WO3.2	✓	✓	✓	✓
WO3.3	✓	✓	✓	✓
<b>Improving Own Learning and Performance</b>				
LP3.1	✓	✓	✓	✓
LP3.2	✓	✓	✓	✓
LP3.3	✓	✓	✓	✓
<b>Problem Solving</b>				
PS3.1	✓	✓	✓	✓
PS3.2	✓	✓	✓	✓
PS3.3	✓	✓	✓	✓

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## C Spiritual, Moral, Ethical, Social and other Issues

### European Dimension

AQA has taken account of the 1988 Resolution of the Council of the European Community in preparing this specification and associated specimen units.

### Environmental Education

AQA has taken account of the 1988 Resolution of the Council of the European

Community and the Report "Environmental Responsibility: An Agenda for Further and Higher Education" 1993 in preparing this specification and associated specimen units.

### Avoidance of Bias

AQA has taken great care in the preparation of this specification and specimen units to avoid bias of any kind.

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## D Overlaps with other qualifications

### USE1 Algebra

Algebra shares significant common content with GCE Mathematics.

Completing the square, familiarity with the shapes of graphs of functions and translations of graphs are encountered in unit Pure Core 1. Laws of logarithms and sine, cosine and tangent graphs are common content with Pure Core 2. Inverse functions are on the specification for Pure Core 3. Exponential growth and decay are encountered in Pure Core 4.

The common content can be found in the following sections of the GCE Mathematics Specification:

In Pure Core 1

Quadratic functions and their graphs.

The discriminant of a quadratic function.

Factorisation of quadratic polynomials.

Completing the square.

Solution of quadratic equations.

Solution of linear inequalities.

Algebraic manipulation of polynomials, including expanding brackets and collecting like terms.

Simple algebraic division.

Graphs of functions; sketching curves defined by simple equations.

Geometrical interpretation of algebraic solution of equations and use of intersection points of graphs of functions to solve equations.

Knowledge of the effect of translations on graphs and their equations.

In Pure Core 2

Knowledge of the effect of simple transformations on the graph of  $y = f(x)$  as represented

by  $y = af(x)$ ,  $y = f(x) + a$ ,

$y = f(x + a)$ ,  $y = f(ax)$ .

$y = a^x$  and its graph.

Logarithms and the laws of logarithms.

The solution of equations of the form

$a^x = b$ .

In Pure Core 3

Combinations of the transformations on the graph of  $y = f(x)$  as represented

by  $y = af(x)$ ,  $y = f(x) + a$ ,

$y = f(x + a)$ ,  $y = f(ax)$ .

The function  $e^x$  and its graph.

The function  $\ln x$  and its graph;  $\ln x$  as the inverse function of  $e^x$ .

In Pure Core 4

Exponential growth and decay.

The compulsory unit USE1 Algebra shares a significant proportion of its content with the non-pilot unit 6991 Working with Algebraic and Graphical Techniques

### 9993 Data Analysis

There is significant content overlap between FSMQ 9993 Data Analysis and the unit Statistics 1 in both GCE Advanced Subsidiary Mathematics and Advanced Subsidiary Statistics. However, the approach to teaching and assessment in FSMQ qualifications is intended to be more concerned with practical application and real world relevance.

Content common to both AS Mathematics and AS Statistics is:

- Measures of Location and Spread, Bivariate Data and Normal Distribution (common with module Statistics 1)

Content common to both GCSE Mathematics and Data Analysis is:

- Statistical Diagrams
- Content common to both GCSE Statistics and Data Analysis is:
- Statistical Diagrams, Bivariate Data, Measures of Location and Spread
- FSMQ 9993 Data Analysis and FSMQ 9994 Hypothesis Testing have some overlap with the existing FSMQ unit 6990, Using & Applying Statistics.

### 9995 Dynamics

There is significant content overlap between FSMQ xxxx Dynamics and the unit Mechanics 1 in GCE Advanced Subsidiary Mathematics. However, the approach to teaching and assessment in FSMQ qualifications is intended to be more concerned with practical application and real world relevance.

Constant acceleration equations and Newton's Laws of Motion are also part of AS Physics specification A, unit 2 (Mechanics and Molecular Kinetic Theory). Kinematics and vectors are common topics between FSMQ Dynamics and AS Physics specification B, unit 1 (Foundation Physics). The concept of momentum is encountered in A2 Physics specification B, module 4 (Further Physics).

### 9996 Mathematical Principles for Personal Finance

The idea of depreciation covered in Mathematical Principles for Personal Finance is also encountered in AS Accounting, module 3 (Financial Accounting: Determination of Income), and in the Accounting and Finance section of A level Business Studies.

There is no significant overlap between Mathematical Principles for Personal Finance and the Intermediate (level 2) FSMQ Financial Calculations.

### 9994 Hypothesis Testing

Hypothesis Testing shares common content with GCE Mathematics, GCE Further Mathematics and GCE Statistics as follows: Addition and Multiplication laws of probability, sampling and the Binomial Distribution are covered in Statistics 1. Null and alternative hypothesis, one and two tailed tests, significance level and critical region are encountered in Statistics 2.

Normal approximation to a binomial distribution is to be found in Statistics 3 of GCE Further Mathematics.

The sign test and Mann-Whitney U test are covered in Statistics 3 of GCE Statistics.

FSMQ 9993 Data Analysis and FSMQ 9994 Hypothesis Testing have some overlap with the existing FSMQ unit 6990, Using & Applying Statistics.

### 9997 Decision Mathematics

Most of the content of Decision Mathematics is common to either unit D1 or unit D2 in the GCE A level Mathematics specification.

Trees and Spanning Trees, Shortest Paths, Route Inspection Problem and Travelling Salesperson Problem are all encountered in unit D1. Critical Path Analysis is common content with D2.

The pilot unit 9997 Decision Mathematics is almost identical in content to the non-pilot unit 6994 Using and Applying Decision Mathematics.

### 9998 Calculus

Calculus shares common content with GCE Mathematics as follows:

Differentiation of functions and second derivatives/maxima and minima are common content with MPC1. Definite and indefinite integrals are also met in MPC1. The Trapezium Rule is covered in MPC2. Integration by inspection and by parts are on the specification for MPC3. Solution of first order differential equations with separable variables is common content with MPC4.

The common content can be found in the following sections of the GCE Mathematics Specification:

In Pure Core 1

The derivative of  $f(x)$  as the gradient of the tangent to the graph of  $y = f(x)$  at a point; the gradient of the tangent as a limit; interpretation as a rate of change.

Differentiation of polynomials

Applications of differentiation to gradients, maxima and minima and stationary points, increasing and decreasing functions.

Second order derivatives.

In Pure Core 2

Integration of  $x^n$ ,  $n \neq -1$ , and related sums and differences.

Approximation of the area under a curve using the trapezium rule.

In Pure Core 3

Differentiation of  $e^x$ ,  $\ln x$ ,  $\sin x$ ,  $\cos x$  and linear combinations of these functions.

Integration of  $e^x$ ,  $\frac{1}{x}$ ,

$\sin x$ ,  $\cos x$ .

Integration by parts.

This method as the reverse process of the product rule.

Evaluation of a volume of revolution.

In Pure Core 4

Exponential growth and decay.

There is significant overlap between 9998 Calculus and the non-pilot 6992 Modelling with Calculus.

### **USE3 Mathematical Comprehension**

The content for Mathematical Comprehension is drawn from the compulsory pilot FSMQ units in Algebra and Calculus.

Simultaneous equations, transformations of graphs and the solution of linear inequalities are common content with Pure Core1.