GCE Subject Level Guidance for Mathematics

April 2016

Contents

Introduction

About this document

This document (highlighted in the figure below) is part of a suite of documents which outlines our guidance for awarding organisations offering GCE Qualifications.

Guidance to the General Conditions of Recognition
For all awarding organisations and all qualifications

GCE Qualification Level Guidance
For all reformed A levels and AS qualifications

GCE Subject Level Guidance
For reformed A levels and AS qualifications in Mathematics

GCE Subject Level Guidance
(other subjects)
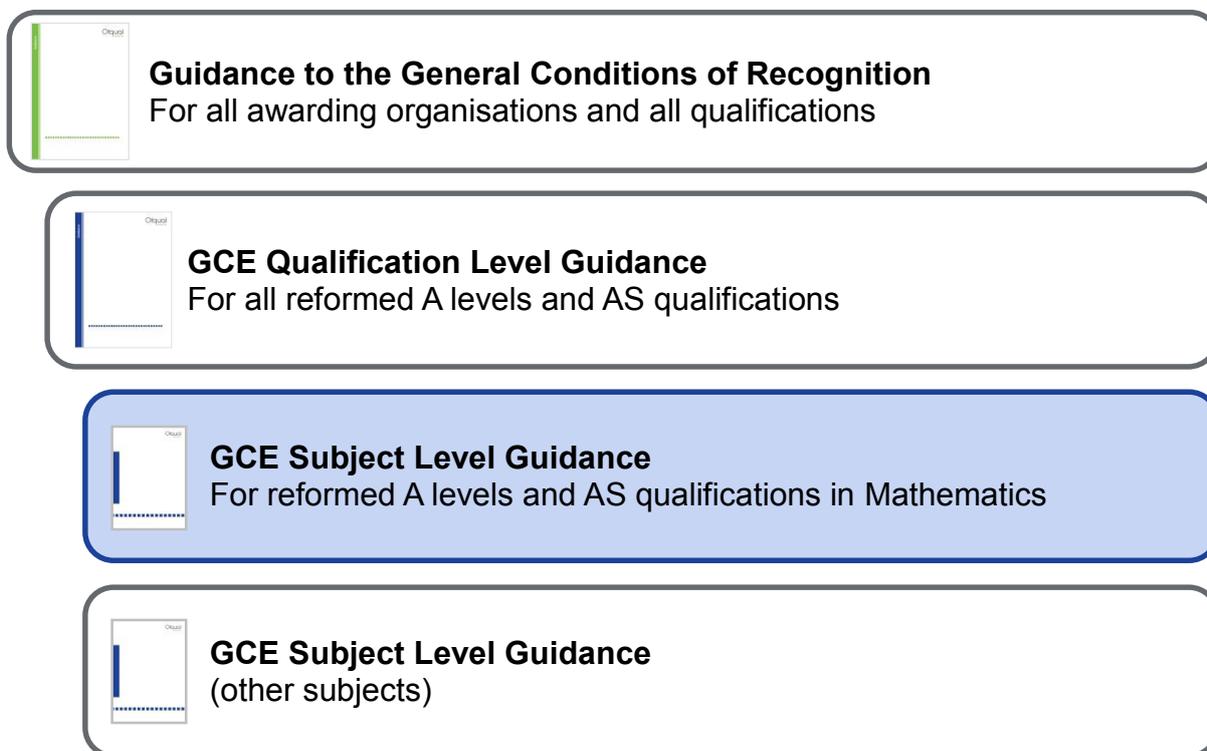
This document sets out guidance which applies to the following qualifications:

■ all GCE A levels in Mathematics which are both –

  ☐ awarded on or after 1 April 2018; and

  ☐ accredited on or after 12.01am on Saturday 9 April 2016; and

■ all standalone GCE AS qualifications in Mathematics awarded on or after 1 April 2018.

It supports the *GCE Subject Level Conditions and Requirements for Mathematics*[1].

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[1] www.gov.uk/government/publications/gce-subject-level-conditions-and-requirements-for-mathematics

This document constitutes guidance for the purposes of section 153 of the Apprenticeships, Skills, Children and Learning Act 2009 (the '2009 Act') and Condition GCE(Mathematics)1.2.

An awarding organisation has a legal obligation under the 2009 Act to have regard to this guidance in relation to each GCE Qualification in Mathematics that it makes available or proposes to make available. Condition GCE(Mathematics)1.2 imposes the same obligation in respect of the guidance below which is issued under that Condition.

An awarding organisation should use the guidance to help it understand how to comply with the requirements set out in *GCE Subject Level Conditions and Requirements for Mathematics*.

Guidance set out in this document

This document provides guidance in relation to subject content, and on assessment objectives, for GCE Qualifications in Mathematics.

Guidance in relation to subject content for GCE Qualifications in Mathematics

The subject content for GCE Qualifications in Mathematics is set out in the Department for Education's *Mathematics AS and A level content*, document reference DFE-00706-2014 (the 'Content Document').

Condition GCE(Mathematics)1.1(c) requires awarding organisations to interpret the Content Document in line with any requirements, and having regard to any guidance, published by Ofqual.

We set out our guidance for the purposes of Condition GCE(Mathematics)1.1(c) below.

Overarching themes and use of technology

Paragraphs 7 and 8 of the Content Document state that –

> 7.   A level specifications in mathematics must require students to demonstrate the following overarching knowledge and skills. These must be applied, along with associated mathematical thinking and understanding, across the whole of the detailed content set out below.
>
> 8.   The use of technology, in particular mathematical and statistical graphing tools and spreadsheets, must permeate the study of AS and A level mathematics.

These statements should be interpreted primarily as indicating the desired approach to teaching GCE Qualifications in Mathematics.

However, these statements also have implications for assessments. Consequently, in respect of each GCE Qualification in Mathematics which it makes available, or proposes to make available, we expect an awarding organisation to explain and justify in its assessment strategy for that qualification how these statements have been reflected in the qualification's design.

Large data sets

Paragraphs 9 and 10 of the Content Document state that –

> 9.   AS and A level mathematics specifications must require students to:
>
> • become familiar with one or more specific large data set(s) in advance of the final assessment (these data must be real and sufficiently rich to enable the concepts and skills of data

presentation and interpretation in the specification to be explored)

- use technology such as spreadsheets or specialist statistical packages to explore the data set(s)

- interpret real data presented in summary or graphical form

- use data to investigate questions arising in real contexts

10.   Specifications should require students to explore the data set(s), and associated contexts, during their course of study to enable them to perform tasks that assume familiarity with the contexts, the main features of the data and the ways in which technology can help explore the data. Specifications should also require students to demonstrate the ability to analyse a subset or features of the data using a calculator with standard statistical functions, as detailed in paragraph 8.

Awarding organisations should interpret the term 'specific large data set(s)' (and related terms) as meaning data sets which:

- consist of real data – the data may be reorganised into a standard format but should not be cleansed by the awarding organisation;

- wherever possible, include the source of the data (including URLs) so that Learners can understand how it was collected;

- may be accompanied by a short piece of text and/or a glossary to help Learners understand the data and associated terminology;

- make clear to Learners whether the whole data set is (essentially) a population, or a sample from a larger population;

- are large enough to manage the risk of predictable assessments, while also being manageable for Centres and capable of supporting the requirements set out in the Content Document;

- contain a mixture of categorical and numerical data; and

- are suitable for analysis using a spreadsheet and/or statistical data package.

Questions/tasks targeting large data sets

The Content Document sets out a clear expectation that assessments will include questions/tasks which relate to the specific large data set(s) studied.

Our expectation is that these questions/tasks should be likely to give a material advantage to Learners who have studied, and are familiar with, the prescribed large data set(s). They might include questions/tasks which:

■ assume familiarity with the terminology and contexts of the data, and do not explain them in a way which provides Learners who have not studied the prescribed data set(s) the same opportunities to access marks as Learners who have studied them;

■ use summary statistics or selected data from, or statistical diagrams based on, the prescribed large data set(s) – these might be provided within the question/task, or as Stimulus Materials;

■ are based on samples related to the contexts in the prescribed large data set(s), where Learners' work with the prescribed large data sets will help them understand the background context; and/or

■ require Learners to interpret data in ways which would be too demanding in an unfamiliar context.

Where an awarding organisation provides a short piece of text and/or a glossary to help Learners understand the data and associated terminology, questions/tasks should require greater engagement with the data than the text and/or glossary provides.

Guidance on assessment objectives for GCE Qualifications in Mathematics

Condition GCE(Mathematics)1.2 allows us to specify requirements and guidance relating to assessment objectives for GCE qualifications in Mathematics.

We published our requirements in relation to assessment objectives in *GCE Subject Level Conditions and Requirements for Mathematics*, and reproduce them in the table below.

	Objective	Weighting (A level)	Weighting (AS)
AO1	**Use and apply standard techniques** Learners should be able to: ■ select and correctly carry out routine procedures; and ■ accurately recall facts, terminology and definitions	*50%*	*60%*
AO2	**Reason, interpret and communicate mathematically** Learners should be able to: ■ construct rigorous mathematical arguments (including proofs); ■ make deductions and inferences; ■ assess the validity of mathematical arguments; ■ explain their reasoning; and ■ use mathematical language and notation correctly. *Where questions/tasks targeting this assessment objective will also credit Learners for the ability to 'use and apply standard techniques' (AO1) and/or to 'solve problems within mathematics and in other contexts' (AO3) an appropriate proportion of the marks for the question/task must be attributed to the corresponding assessment objective(s).*	*25%*	*20%*
AO3	**Solve problems within mathematics and in other contexts**	*25%*	*20%*

Learners should be able to:

■ translate problems in mathematical and non-mathematical contexts into mathematical processes;

■ interpret solutions to problems in their original context, and, where appropriate, evaluate their accuracy and limitations;

■ translate situations in context into mathematical models;

■ use mathematical models; and

■ evaluate the outcomes of modelling in context, recognise the limitations of models and, where appropriate, explain how to refine them.

Where questions/tasks targeting this assessment objective will also credit Learners for the ability to 'use and apply standard techniques' (AO1) and/or to 'reason, interpret and communicate mathematically' (AO2) an appropriate proportion of the marks for the question/task must be attributed to the corresponding assessment objective(s).

We set out below our guidance for the purposes of Condition GCE(Mathematics)1.2. This guidance explains how we expect awarding organisations to interpret these assessment objectives in terms of:

■ the different 'strands' within each of the assessment objectives;

■ the discrete 'elements' within each assessment objective and its strands which questions and tasks could target and/or seek to credit – our expectation is that each and every question/task should target or seek to credit at least one of these elements, and may target or seek to credit multiple elements across one or more assessment objectives;

■ the coverage expectations, such as in relation to the different elements within each assessment objective and how those elements should be sampled over time; and

■ the key areas of emphasis in each assessment objective and the particular meaning for the subject of any key terms and phrases used; defined terms are shown in bold text, followed by their definitions.

In line with the obligations set out in Condition GCE(Mathematics)1.2, we expect awarding organisations to be able to demonstrate how they have had regard to this guidance. For example, an awarding organisation could map how it has regard to the guidance as it:

■   develops its sample assessment materials;

■   delivers the qualification;

■   develops and applies its approach to sampling the elements into which the assessment objectives are divided; and

■   monitors the qualification to make sure it addresses all elements appropriately.

AO1: Use and apply standard techniques				50% (A level) 60% (AS)

AO1: Use and apply standard techniques

Learners should be able to:
- **select and correctly carry out routine procedures**
- **accurately recall facts, terminology and definitions**

50% (A level)

60% (AS)

Strands	Elements	Coverage	Interpretation and definitions
1 – select and correctly carry out routine procedures	1a – select routine procedures	▪ Full coverage in each set of assessments (but not every assessment). ▪ No more than 10% of the marks for this assessment objective should be allocated solely to strand 2.	▪ **Routine procedures** includes multi-step as well as single-step processes. They should be familiar to the Learner (including, but not limited to, those stated in the specification) and there should be no significant background context given in the question/task that would have an impact on the Level of Demand.
	1b – correctly carry out routine procedures		▪ **Select** involves the recognition of a single- or multi-step process necessary to carry out a routine procedure (for example, solving a quadratic equation or integrating a function) in cases where the question/task does not make the required process clear. It should not be confused with the more complex decision-making required in AO3.
2 – accurately recall facts, terminology and definitions	This strand is a single element		▪ Element 1a should normally be assessed in combination with element 1b. ▪ Within strand 2, individual questions/tasks may target each of facts, terminology and definitions in isolation, or in any combination.

			25% (A level)
AO2: Reason, interpret and communicate mathematically **Learners should be able to:** ▪ **construct rigorous mathematical arguments (including proofs)** ▪ **make deductions and inferences** ▪ **assess the validity of mathematical arguments** ▪ **explain their reasoning** ▪ **use mathematical language and notation correctly**			20% (AS)

Strands	Elements	Coverage	Interpretation and definitions

1 – construct rigorous mathematical arguments (including proofs)	This strand is a single element	▪ Full coverage in each set of assessments (but not every assessment).
		 ▪ Taken together, strands 1 and 2 should comprise at least 50% of the marks for this assessment objective.
		 ▪ No more than 10% of the marks for this assessment objective should be allocated to strand 3.
		 ▪ No more than 10% of the marks for this assessment objective should be allocated solely to strand 5.
			▪ A **mathematical argument** leads from premises to a conclusion, through rigorous and clear reasoning. It:
			   □ may include one or both of calculations or algebraic manipulation, but is more than these alone,
			   □ typically involves several steps, which are logical in nature and sequence, given the context,
			   □ clearly identifies the principal results used where appropriate, and
			   □ contains sufficient detail to allow the line of reasoning to be followed.
			 ▪ **Deduction** means a process of reasoning from known results to conclusions that must be correct.
			 ▪ **Inference** means a process of reasoning from relative or partial evidence to results that are likely to be correct.
			 ▪ Strand 3 could apply to **arguments** provided to a Learner, or to arguments generated by them. It may include identifying:

2 – make deductions and inferences	2a – make deductions		
	2b – make inferences		
3 – assess the validity of mathematical arguments	This strand is a single element		
4 – explain their reasoning	This strand is a single element		

Strands	Elements	Coverage	Interpretation and definitions
5 – use mathematical language and notation correctly	This strand is a single element		▫ errors and/or omissions; and ▫ the values for, and/or conditions under, which an argument remains correct. ■ In the context of strand 4, **explain** may include providing justification for a particular approach. Justification and/or explanation of key steps in the working should be required even where problems are otherwise fairly routine in nature. ■ Strands 4 and 5 should normally be assessed in combination with strands 1, 2 and/or 3. Learners should be given multiple opportunities to demonstrate (and gain credit for) the skills required by these strands.

AO2: Reason, interpret and communicate mathematically

Learners should be able to:
- construct rigorous mathematical arguments (including proofs)
- make deductions and inferences
- assess the validity of mathematical arguments
- explain their reasoning
- use mathematical language and notation correctly

25% (A level)

20% (AS)

	AO3: Solve problems within mathematics and in other contexts			*25% (A level)*
	Learners should be able to: ▪ **translate problems in mathematical and non-mathematical contexts into mathematical processes** ▪ **interpret solutions to problems in their original context, and, where appropriate, evaluate their accuracy and limitations** ▪ **translate situations in context into mathematical models** ▪ **use mathematical models** ▪ **evaluate the outcomes of modelling in context, recognise the limitations of models and, where appropriate, explain how to refine them**			*20% (AS)*
Strands	**Elements**	**Coverage**	**Interpretation and definitions**	
1 – translate problems in mathematical and non-mathematical contexts into mathematical processes	1a – translate problems in mathematical contexts into mathematical processes 1b – translate problems in non-mathematical contexts into mathematical processes	▪ Full coverage of all elements except 2b and 5c in each set of assessments (but not every assessment). ▪ Elements 2b and 5c should be covered over the shortest period of time that is	▪ **Translate problems** may involve the Learner selecting and/or constructing appropriate mathematical processes. It may include identifying important features or variables. ▪ **Translate situations in context** may involve the Learner selecting and/or constructing appropriate mathematical models. It may also entail constructing a model of a specific situation, following the principles of an established modelling process. It may include identifying important features or variables. ▪ Within strands 2 and 5, **where appropriate** means where it is meaningful to do so in the context of the question/task. ▪ Within strand 2, evaluating the accuracy and limitations of a solution may (but need not) extend to the problem-solving process used in generating it.	

AO3: Solve problems within mathematics and in other contexts			25% (A level)
Learners should be able to: ■ translate problems in mathematical and non-mathematical contexts into mathematical processes ■ interpret solutions to problems in their original context, and, where appropriate, evaluate their accuracy and limitations ■ translate situations in context into mathematical models ■ use mathematical models ■ evaluate the outcomes of modelling in context, recognise the limitations of models and, where appropriate, explain how to refine them			20% (AS)

Strands	Elements	Coverage	Interpretation and definitions

2 – interpret solutions to problems in their original context, and, where appropriate evaluate their accuracy and limitations	2a – interpret solutions to problems in their original context	reasonably practicable (but not necessarily in every set of assessments).
		
		■ Taken together, strands 1 and 2 should comprise at least 40% of the marks for this
			■ Within strand 3, the context may be either mathematical or non-mathematical.
			■ A problem-solving question/task would typically exhibit[2] one or more of the following attributes –
			  □ Little or no scaffolding – the Learner receives little guidance beyond a start point and a finish point, and the mathematical processes required for the solution are not explicitly stated
			  □ Provision for multiple representations (such as the use of a sketch or diagram as well as calculations)

	2b – where appropriate, evaluate [the] accuracy and limitations [of solutions to problems]		

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[2] The list of attributes is not intended to be exhaustive; nor do we expect an individual question/task to exhibit all of the attributes.

AO3: Solve problems within mathematics and in other contexts			*25% (A level)*
Learners should be able to: ■ translate problems in mathematical and non-mathematical contexts into mathematical processes ■ interpret solutions to problems in their original context, and, where appropriate, evaluate their accuracy and limitations ■ translate situations in context into mathematical models ■ use mathematical models ■ evaluate the outcomes of modelling in context, recognise the limitations of models and, where appropriate, explain how to refine them			*20% (AS)*

Strands	Elements	Coverage	Interpretation and definitions
3 – translate situations in context into mathematical models	This strand is a single element	assessment objective. ■ Taken together, strands 3, 4 and 5 should comprise at least 40% of the marks for this assessment objective.	□ Information is not given in mathematical form or mathematical language, or results and/or methods need to be interpreted and/or evaluated (for example, in a real-world context) □ A choice of techniques to be used □ The solution requires understanding of the processes involved, rather than just application of techniques □ Two or more mathematical processes are required, or the solution requires drawing together different parts of mathematics ■ Each set of assessments should include questions/tasks where Learners are assessed on their ability to solve complete
4 – use mathematical models	This strand is a single element		
5 – evaluate the outcomes of modelling in context,	5a – evaluate the outcomes of modelling in context		

AO3: Solve problems within mathematics and in other contexts			*25% (A level)*
Learners should be able to: ▪ translate problems in mathematical and non-mathematical contexts into mathematical processes ▪ interpret solutions to problems in their original context, and, where appropriate, evaluate their accuracy and limitations ▪ translate situations in context into mathematical models ▪ use mathematical models ▪ evaluate the outcomes of modelling in context, recognise the limitations of models and, where appropriate, explain how to refine them			*20% (AS)*

Strands	Elements	Coverage	Interpretation and definitions

recognise the limitations of models and, where appropriate, explain how to refine them	5b – recognise the limitations of models
	
	5c – where appropriate, explain how to refine [models]
			problems presented in an unstructured manner and which require the use of multiple parts of the problem-solving cycle (as defined in overarching theme 2 on page 4 of the Content Document).
			▪ Within each set of assessments, there should be opportunities for both –
			  □ extended questions/tasks that address strands 1 and 2 in combination, and
			  □ extended questions/tasks that address strands 3, 4 and 5 in combination.

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