Accredited

GCSE (9-1)

Transition Guide

J560

MATHEMATICS

Theme: Equations

December 2016

OCR

Oxford Cambridge and RSA

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Welcome

Welcome to the KS3–KS4 transition guide for **Maths.**

Key Stage 3 to 4 Transition Guides focus on how a particular topic is covered at the different key stages and provide information on:

- Differences in the demand and approach at the different levels;
- Useful ways to think about the content at Key Stage 3 which will help prepare students for progression to Key Stage 4;
- Common student misconceptions in this topic.

Transition guides also contain links to a range of teaching activities that can be used to deliver the content at Key Stage 3 and 4 and are designed to be of use to teachers of both key stages. Central to the transition guide is a Checkpoint task which is specifically designed to help teachers determine whether students have developed deep conceptual understanding of the topic at Key Stage 3 and assess their 'readiness for progression' to Key Stage 4 content on this topic. This checkpoint task can be used as a summative assessment at the end of Key Stage 3 teaching of the topic or by Key Stage 4 teachers to establish their students' conceptual starting point.

Key Stage 3 to 4 Transition Guides are written by experts with experience of teaching at both key stages.

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Key Stage 3 Content

Key Stage 3 National Curriculum Content

- Understand and use the concepts and vocabulary of expressions, equations, inequalities, terms and factors.
- Use algebraic methods to solve linear equations in one variable (including all forms that require rearrangement).
- Reduce a given linear equation in two variables to the standard form $y = mx + c$.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/239058/SECONDARY_national_curriculum_-_Mathematics.pdf

KS3 ⇨ KS4

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Key Stage 4 Content

GCSE (9-1) content Ref.	Subject content	Initial learning for this qualification will enable learners to...	Foundation tier learners should also be able to...	Higher tier learners should additionally be able to...	DfE Ref.
6.03	**Algebraic equations**				
6.03a	Linear equations in one unknown	Solve linear equations in one unknown algebraically. e.g. Solve $3x - 1 = 5$	Set up and solve linear equations in mathematical and non-mathematical contexts, including those with the unknown on both sides of the equation. e.g. Solve $5(x - 1) = 4 - x$ Interpret solutions in context.	*[Examples may include manipulation of algebraic fractions, 6.01g]*	A3, A17, A21
6.03b	Quadratic equations		Solve quadratic equations with coefficient of x^2 equal to 1 by factorising. e.g. Solve $x^2 - 5x + 6 = 0$. Find x for an x cm by $(x + 3)$ cm rectangle of area 40 cm^2.	Know the quadratic formula. Rearrange and solve quadratic equations by factorising, completing the square or using the quadratic formula. e.g. $2x^2 = 3x + 5$ $\frac{2}{x} - \frac{2}{x+1} = 1$	A18
6.03c	Simultaneous equations		Set up and solve two linear simultaneous equations in two variables algebraically. e.g. Solve simultaneously $2x + 3y = 18$ and $y = 3x - 5$	Set up and solve two linear simultaneous equations (one linear and one quadratic) in two variables algebraically. e.g. Solve simultaneously $x^2 + y^2 = 50$ and $2y = x + 5$	A19, A21
6.03d	Approximate solutions using a graph	Use a graph to find the approximate solution of a linear equation.	Use graphs to find approximate roots of quadratic equations and the approximate solution of two linear simultaneous equations.	Know that the coordinates of the points of intersection of a curve and a straight line are the solutions to the simultaneous equations for the line and curve.	A11, A17, A18 A19
6.03e	Approximate solutions by iteration			Find approximate solutions to equations using systematic sign-change methods (for example, decimal search or interval bisection) when there is no simple analytical method of solving them. Specific methods will not be requested in the assessment.	A20, R16

http://www.ocr.org.uk/Images/168982-specification-gcse-mathematics-j560.pdf

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Difference between the level of demand at Key Stage 3 and Key Stage 4

All students at Key Stage 3 should have plenty of experience in solving equations and manipulating algebraic terms. Students will mainly have worked with linear equations with one unknown.

Common misconceptions should be highlighted and discussed at Key Stage 3 so that students go into Key Stage 4 with a clear understanding of how to solve any linear equation. In particular, teachers will need to establish whether students have a deep understanding of the process of solving equations or whether they have simply learned an algorithmic approach to solving the most straightforward examples. Students of middle ability may appear to be able to successfully solve a range of equations but have little understanding of the structures underpinning the process they follow, creating significant barriers to generalising when solving less common examples.

Teachers should aim to ensure that the increased level of demand in solving non-linear equations and simultaneous equations is not hindered by a lack of understanding of the more basic concepts.

There is likely to be a substantial increase in the level of demand for weaker students, who at Key Stage 3 will have only worked with more straightforward examples. At Key Stage 4, the expectation is that all students can solve all types of linear equation in one unknown.

Deriving and solving simultaneous equations is now part of the Key Stage 4 content for all students. All students will be expected to be able to solve linear examples of these and more able students will be expected to consider examples with one quadratic and one linear. All students should be given plenty of opportunity to work with contextual examples of simultaneous equations so that they have full understanding of their use and ensure that they are able to interpret the final result in the context of the initial situation.

Next

Solving quadratics using factorising is now required content at Key Stage 4 for all students; higher attaining students should be able to solve quadratics using the many different methods, including the use of the formula. This is a big change from the pre-2015 curriculum and weaker students will need support to understand the increase in the level of demand. Some students may only be able to work with the most simple of examples.

Common misconceptions

It is important to ensure that any misconceptions with the basics of solving equations are covered prior to moving on to other types of equations. Common misconceptions are below:

- Students assume that subtraction is commutative like addition.
- Misuse of the '=' symbol e.g. $5 - x = 6 = x = {}^{-}1$.
- Change side-change sign rule forgetting to include all terms.
- Students often forget to multiply or divide each term in the whole equation.

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Delivering the Key Stage 4 content

Higher achieving students will be expected to be completely fluent in solving the different types of equations and to be able to consider further contextual examples, especially those involving graphs of the equations and the different methods for solving. Solving using iteration is a new element of the curriculum for higher attaining students.

Topics such as deriving and solving simultaneous equations and factorising quadratics, which are now required at both Higher and Foundation tiers, will need very careful handling for students aiming at grades 1- 3. It would be sensible for teachers to use only the simplest examples to ensure that these topics are accessible to these students.

The change in delivery style for the new GCSE brings in the use of more contextual examples and an increased focus on proof and problem solving. The equation content of the GCSE course allows for simple justification of solutions in each lesson as well as looking at more formal elements of proof. Using this, alongside a problem solving approach, will increase the level of understanding of the use of equations rather than just concentrating on the manipulation of algebra following a system of rules.

Possible Teaching Activities (KS3 focus)

This resource is from the DfE Standards Unit (2000 – 2009).

This task allows students to create and solve their own equations where the unknown appears once and to develop confidence with the notation and structure of equations.

It allows teachers to question students in order to highlight misconceptions with the basic rules for equations. This is also a group activity so the students can learn from each other.

Resources: http://www.nationalstemcentre.org.uk/elibrary/resource/1999/creating-and-solving-equations-a2

A large selection of resources that allows students to solve simple equations, 2-step equations and those where the unknown appears on both sides. There are also a variety of contextual resources for students to extend their understanding.

Resources: http://www.nationalstemcentre.org.uk/elibrary/list/7911/solving-linear-equations

This allows students to follow examples, use the interactive questions and then try some examples with the solutions. The page also links back to the tutorials for further help for students who are unsure.

Resources: http://www.cimt.plymouth.ac.uk/projects/mepres/book8/bk8i12/bk8_12i4.htm

Ten students think of a number then perform various operations on that number and give the answer; students work to find the missing number. This is a very useful starting point for solving equations without the structure of algebra.

Resources: http://www.transum.org/software/SW/Starter_of_the_day/students/Thoan.asp

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Possible Teaching Activities (KS3 focus)

This is a full lesson unit which allows teachers to assess how well students can solve linear equations in one variable, collect like terms and categorise equations into those that have one, none or many solutions. It should also allow time for discussion of misconceptions in algebra.

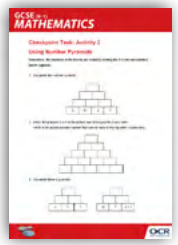
Resources: http://map.mathshell.org/download.php?fileid=1686

Checkpoint Task

The Checkpoint Task is a series of three activities that aims to form a basis for formative assessment at the end of Key Stage 3, or at the start of Key Stage 4. The activities focus on solving equations in one variable including those that require some rearrangement.

Students are encouraged to work together and to engage with the activities. They should be allowed thinking time prior to asking for support. Further support can be given through careful questioning or perhaps through scaffolding the resources.

Starter Activity
Students should use their knowledge of rearranging equations to demonstrate their understanding. The aim of the activity is to develop multiple interesting forms of the initial equation using the rules for manipulating and solving equations. The initial equation can be differentiated to allow students to show their understanding or to scaffold the task as needed.



Activity 2: Using Number Pyramids
Students complete number pyramids by adding the 2 numbers directly underneath. They begin by completing the number pyramids, then can move on to collecting like terms examples or straight to the solving equations examples, depending on levels of understanding. Students could work individually or in groups to complete this activity. Students should verify the solutions in groups and be prepared to justify their working to each other.

Activity 3: Generalising Equations
Students show that they can solve equations with the unknown on both sides before using this knowledge to find a solution to a general equation with the unknown on both sides. Students should be encouraged to manipulate the equation to define their own rules for solving equations. Assessment should be made through asking questions as the students are completing the activity and allowing time for peer assessment.

Checkpoint task instructions: www.ocr.org.uk/Images/349133-ks3-ks4-transition-guide-equations-checkpoint-task-teacher-instructions.docx

Checkpoint task activity: www.ocr.org.uk/Images/349134-ks3-ks4-transition-guide-equations-checkpoint-task.docx

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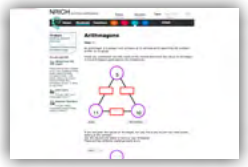
Possible Teaching Activities (GCSE Focus)

Students have the opportunity to create quadratic equations and solve them by factorisation or by using the quadratic formula. The follow-up questions offer the chance for some interesting generalisations and justifications. This task is ideal for students who have already been introduced to solving quadratic equations.

Resources: http://nrich.maths.org/631



This task allows the students to explore number patterns without the use of symbols, which enables the students to begin to generalise.

Resources: http://nrich.maths.org/2670

This is a large selection of algebra tasks, covering all aspects of the algebra content in the specification.

Resources: http://www.mrbartonmaths.com/algebra.htm

This treasure hunt allows students to revise their equation knowledge individually or in groups.

Resources: http://www.tes.co.uk/teaching-resource/Treasure-hunt-and-39-GCSE-target-C-and-39-Game-KS4-Ages14-16-6017613/

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Possible Teaching Activities (GCSE Focus)

An explanation of quadratic equations with plenty of examples of the different ways they can be used, presented and solved.

Resources: http://www.mathsisfun.com/algebra/quadratic-equation.html

Possible Challenge and Extension Tasks

This task allows students to practice the techniques for solving simultaneous equations. It is a non-typical example as it involves a system of equations. The idea is designed for students to think for themselves and use their understanding.

Resources: http://nrich.maths.org/543

This resource is from the DfE Standards Unit (2000 – 2009). This task should allow students to identify different forms and properties of quadratic functions and connect these functions with the graphs and properties.

Resources: http://www.nationalstemcentre.org.uk/elibrary/resource/2059/linking-the-properties-and-forms-of-quadratic-equations-c1

This Subtangent test progresses from students identifying quadratic expressions, expanding brackets and factorising expressions to solving quadratic equations. Students are given four possible answers to choose from and there is an opportunity to review their choices before submitting their final answers. An explanation of the correct answers, to support learning, is given when the test is reviewed.

This is a Flash resource.

Resources: http://www.nationalstemcentre.org.uk/elibrary/maths/resource/602/quadratics-1

This video goes through how to solve a linear and quadratic simultaneous equation using the substitution method and solving using factorising. This should help anyone trying to get the top grade at GCSE or who is studying C1 A Level maths.

Resources: http://www.tes.co.uk/teaching-resource/Harder-Simultaneous-Equations-video-6297000/

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Resources, Links and Support

Additional Topic 1

Additional Topic 2

Additional Topic 3

As we develop Transition Guides for further topics we'll update these links, making it easy for you to browse all the guides for your chosen subject.

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