

Round 4: Algebra Challenge

1. OBJECTIVES:

- To develop problem solving skills.
- To develop fluency in algebra.

2. DESCRIPTION AND RATIONALE:

Problem solving is a key component of the mathematics national curriculum. Problem solving and maths in contexts are key elements of GCSE exams. In this round, students are placed into a story driven context where they will have to solve problems using information they have been given in a scenario based around a story-based theme.

A vital component of the GCSE exam is that students read a complex multi-step problem and find and use the information needed to solve it. This round works in exactly that way. Students must carefully listen for or read instructions and make sense of them and solve problems to provide information and interpret it.

The final and perhaps most important area of fluency that students need to develop to be fully prepared and confident to take on A-level and further study in mathematics, is algebra. It is often said that algebra is a language and students must learn to speak it fluently. However, it is frequently taught as a series of disconnected manipulations and students struggle to make sense of its purpose. In this round, students will solve algebraic equations, manipulate expressions, evaluate functions and substitute into formulae, read, draw and interpret straight line graphs, and use numbers in a linear sequences, for the purpose of generating solutions which will provide them with information to solve a significant problem.

3. SCHOOL ACTIVITIES:

In Class

1. Explore the history of Algebra and the contributions of different cultures. The excellent Wikipedia article is a good starting point for the teacher. Students could choose one of the themes and research further. They could make a poster to share their work. www.en.wikipedia.org/wiki/History_of_algebra.
2. Use algebra to solve mathematical problems. Give students opportunities to solve open problem tasks from the NRich web site. Encourage them to use algebra to describe, explain and prove their findings. NRich has a number of themed collections of algebra activities:
 - a. 'What's Algebra All About' contains easier stage 2 problems and is a good starting point for anyone: www.nrich.maths.org/10955
 - b. 'Pattern' and 'Equations and Formulae' contain interesting practical problems at NRich difficulty stages 3, 4 and 5: www.nrich.maths.org/9512 and www.nrich.maths.org/9516

Clubs and Tournament

There are three elements to solving the problem. We would suggest that each is practiced independently.

1. Teams will need to access information from documents, maps, pictures and sets of instructions given in different forms. The critical skill is to look for key information from given clues.
2. Students will need to solve equations, manipulate algebra, read and interpret graphs and other algebraic problems of any type included in the National Curriculum. A complete list of the possible algebra involved is given in appendix 2 at the back of this guide.
3. There is a small collection of complete materials sets with teacher instructions from previous tournaments. We recommend that you get at least one set and set it up as an activity. One example is used in the training session. This way students will get a sense of what to expect. These are only a guide and events will differ significantly. For schools that have been in the challenge for many years, it is important stress that in earlier years, there was a significant coding element in this round. That is not longer the case and most especially, algebraic graphs have now been included.

4. MATERIALS:

In the student's workbook there are details for finding Tarsia algebra problems and details for using GeoGebra to explore algebraic equations, manipulations and graphs.

For practice in a team working environment similar to the competition, we would recommend solving equations using Tarsia puzzles. An excellent resource is provided by Craig Barton.

Follow this link and download the Algebra set: <http://www.mrbartonmaths.com/teachers/rich-tasks/tarsia-jigsaw.html>

Note you also need the (free) software at: www.mmlsoft.com/index.php/products/tarsia

5. AT THE COUNT ON US SECONDARY CHALLENGE:

- The Challenge will be based in a problem-solving story involving some features of London. Teams will need to solve problems and puzzles involving algebraic equations, manipulations and graphs.
- Teams will score points for the algebra problems and the puzzles they solve, plus a bonus for solving the overall problem.
- Teams will work from their group base. They will need to carefully read the information they gain access to and make sure they understand and develop a plan to solve the problem. One team member will take the role of 'runner'. Their job will be to take items to institutions and collect further items at stations staffed by a judge.
- Notice that the nature of problem solving requires that this description is quite vague. The way each round will operate will vary as the problem to be solved varies. Expect the unexpected!

LIST OF REQUIRED ALGEBRA CONTENT

1. Use and interpret algebraic notation, including:
 - ab in place of $a \times b$
 - $3y$ in place of $y + y + y$ and $3 \times y$
 - a^2 in place of $a \times a$, a^3 in place of $a \times a \times a$; a^2b in place of $a \times a \times b$
 - $\frac{a}{b}$ in place of $a \div b$
 - coefficients written as fractions rather than as decimals
 - brackets
2. Substitute numerical values into formulae and expressions, including scientific formulae.
3. Understand and use the concepts and vocabulary of expressions, equations, inequalities, terms and factors.
4. Simplify and manipulate algebraic expressions to maintain equivalence by:
 - collecting like terms
 - multiplying a single term over a bracket
 - taking out common factors
 - expanding products of two or more binomials
5. Use algebraic methods to solve linear equations in one variable (including all forms that require rearrangement).
6. Work with coordinates in all four quadrants.
7. Recognise, sketch and produce graphs of linear and quadratic functions of one variable with appropriate scaling, using equations in x and y and the Cartesian plane.
8. Find approximate solutions to contextual problems from given graphs of a variety of functions, including piece-wise linear, exponential and reciprocal graphs.
9. Sequences:
 - Generate terms of a sequence from either a term-to-term or a position-to-term rule
 - Recognise arithmetic sequences and find the n th term
 - Recognise geometric sequences and appreciate other sequences that arise.