

## 13+ PAST PAPER PACK

# Oundle School 13+ Maths 2023

## Complete Past Paper Pack

### CONTENTS

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#### 01 Question Paper

Oundle School 13+ Maths. Work through this paper first.

Includes Paper Notes: overview, topics, revision tips, common mistakes.

#### 02 Question Paper

Oundle School 13+ Maths. Work through this paper first.

Includes Paper Notes: overview, topics, revision tips, common mistakes.

#### 03 Question Paper

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**EXAMINATION PAPER**  
**Non Common Entrance 2023**

**Mathematics**

**Time allowed: 1 hour**

**Name:** \_\_\_\_\_

**Instructions**

- Calculators are **NOT** allowed.
- Write **ALL** your working and answers on this paper. Show enough working on each question to make it clear how you reached your answer.
- Do not spend too long working on any particular question. Do not worry if you do not manage to complete every question.
- You may work in pen or pencil.

**Question 1**

In a fishing competition an angler called Bob catches 5 fish, weighing:

1.75 kg, 1.4 kg, 0.98 kg, 3.6 kg, 2.7 kg

(a) What is the difference in weight between the biggest and smallest fish?

Answer .....

(b) What is the total weight of the five fish?

Answer .....

(c) Using your answer to (b), calculate the mean weight of the fish.

Answer .....

(d) The winner of the “heaviest fish” prize, Paul, caught a fish 2.8 times the weight of Bob’s heaviest catch. How heavy was the winning fish?

Answer .....

**Question 2** Work out the following, obeying the correct order of operations.

(a)  $4 + 6 \times 9 - 7$

Answer .....

(b)  $20 + 2 \times (10 - 3 \times 2)$

Answer .....

(c)  $4 \times 3^2 - (2 - 1)$

Answer .....

(d)  $8 + 7 - 4 + 3$

Answer .....

**Question 3** Calculate the following. Your answers should be fully simplified and written as a mixed number where appropriate.

(a)  $\frac{2}{5} + \frac{3}{4}$

Answer .....

(b)  $\frac{5}{12} - \frac{5}{16}$

Answer .....

(c)  $\frac{3}{22} \times \frac{14}{15}$

Answer .....

(d)  $\frac{7}{9} \div \frac{16}{21}$

Answer .....

**Question 4**

- (a) Write 105 as a product of its prime factors

Answer .....

- (b) List all of the factors of 105, in ascending order

Answer .....

**Question 5**

- (a) An event organiser is preparing for a conference. Each attendee will receive a pen and a pad of paper. Pens come in packs of 20 and pads of paper come in packs of 12. The organiser is able to order exactly the right number of packs of each, with no pens or pads left over. What is the smallest possible number of attendees?

Answer .....

- (b) A chocolatier has some left over chocolates which they decide to split into “bargain bags”. There are 24 dark chocolates, 32 milk chocolates and 16 white chocolates. Each bag must have identical contents, and all the chocolates must be used. What is the greatest number of “bargain bags” the chocolatier can make in this way?

Answer .....

**Question 6**

If  $a = 5$ ,  $b = -4$  and  $c = 2$ , find the value of the following expressions

(a)  $a - bc$

Answer .....

(b)  $\frac{ab^2}{c}$

Answer .....

(c)  $2(a + c) - 2b$

Answer .....

**Question 7** Fully simplify the following algebraic expressions

(a)  $5a - 3b - a - 9b$

Answer .....

(b)  $4x - 2x - 6 + x + 15$

Answer .....

(c)  $4xy - 7x + 2y + 3x$

Answer .....

(d)  $(2x)^2 \times 3xy$

Answer .....

**Question 8** Solve the following equations, leaving your answers as improper fractions where necessary.

(a)  $6x - 5 = 13$

Answer .....

(b)  $\frac{2}{3}x - 4 = 10$

Answer .....

(c)  $5(2x - 7) = 15$

Answer .....

(d)  $7x - 8 = 12 - 3x$

Answer .....

(e)  $\frac{2x+3}{4} = 2$

Answer .....

(f)  $2x + \frac{3}{5} = \frac{1}{2}x - 3$

Answer .....

**Question 9**

For the following questions you must form and solve an equation.

- (a) I think of a number, add eighteen, then double the result; I now have 32.  
What was the number I thought of?

Equation .....

Solution .....

- (b) Ross, George and Trudie combine their savings to buy a toy costing £50. Ross contributes £5 more than Trudie, and George contributes three times more than Ross.  
How much did George contribute?

Equation .....

Solution .....

**Question 10**

Stan and Olivia bake 28 pies for market day; Stan bakes 8 more pies than Olivia.

- a) What is the ratio of the number of pies Stan bakes to the number of pies Olivia bakes?

Answer .....

The next week Stan and Olivia bake pies for market day again. Stan bakes 8 more pies than Olivia again, but this time the ratio of the number of pies Stan bakes to the number of pies Olivia bakes is 3:2.

- b) How many pies did they bake in total?

Answer .....

**Question 11**

Saul buys a guitar for £350, and later sells it to Gilbert for a 10% profit. Gilbert then sells the guitar to someone else and makes £11.20 more profit than Saul.

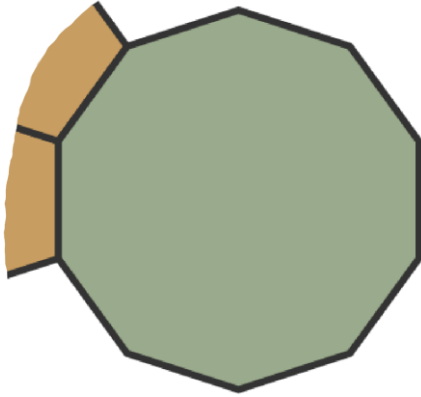
What percentage profit did Gilbert make on the guitar?

Answer .....

**Question 12**

A design for a sunflower is made using tiles; one, a decagon (forming the centre), surrounded by ten identical regular polygons (forming the petals). The diagram below shows part of the design. Calculate the number of sides of each of the “petals”.

*(answers without supporting working will receive few/no marks)*



Answer .....

# Paper Notes: 13+ Maths Question Paper (13+ Maths Past Paper (2023))

Compiled by [SATs-Papers.co.uk](https://www.SATs-Papers.co.uk) to help you get the most from this paper.

## Overview

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This is the **Oundle School Non-Common Entrance 2023 Mathematics paper**, a 13+ entrance examination for pupils seeking entry to Year 9 at Oundle School in Northamptonshire. The paper is designed for candidates who are not sitting the Common Entrance exam, providing an alternative route into the school.

The examination tests a broad range of **mathematical topics** across number, algebra, ratio, and geometry. Questions are presented in a free-response format with working space provided on the paper itself. Calculators are **not permitted**, placing emphasis on mental arithmetic, estimation skills, and clear written methods. The paper comprises twelve questions of varying length and difficulty, with sub-parts building from straightforward calculations to multi-step problem-solving.

This paper is ideal for pupils preparing for independent school entrance at 13+, particularly those applying to schools that set their own entrance papers rather than relying solely on Common Entrance. The mix of straightforward and challenging questions allows candidates to demonstrate both core competency and mathematical reasoning, making it suitable for practice under timed conditions (one hour) as well as for diagnostic review of strengths and weaknesses.

## How this paper is organised

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The paper is allocated **one hour** of examination time and consists of **twelve questions**, many of which contain multiple sub-parts. Questions 1 to 8 focus primarily on number work, order of operations, fractions, and algebra, whilst Questions 9 to 12 introduce worded problems, ratio, percentages, and geometry.

Marks are not explicitly stated on the paper, but the instruction to show all working suggests that partial credit is available for method even when final answers are incorrect. The paper is designed to be completed directly on the question sheet, with answer lines provided after each part. Space for working is generous, particularly for the later questions which demand extended reasoning.

The final question (Question 12) on polygon angle properties carries a warning that answers without supporting working will receive few or no marks, signalling that this is a higher-demand problem where method marks are critical. The progression from arithmetic in the early questions to algebraic manipulation and geometric proof later

mirrors the structure of many 13+ entrance papers, allowing weaker candidates to score well on accessible material whilst stretching the most able.

## Topics covered

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- Decimal arithmetic including addition, subtraction, and multiplication of decimals in real-world contexts (fishing competition weights)
- Mean (average) calculation from a set of data values
- Order of operations (BIDMAS/BODMAS) with integers, including brackets, powers, and mixed operations
- Fraction arithmetic: addition, subtraction, multiplication, and division of fractions, with simplification and conversion to mixed numbers
- Prime factorisation of composite numbers and listing all factors of a given integer
- Lowest common multiple (LCM) and highest common factor (HCF) in problem-solving contexts
- Substitution into algebraic expressions involving negative numbers, powers, and order of operations
- Simplification of algebraic expressions by collecting like terms and expanding brackets
- Solving linear equations including those with brackets, fractions, unknowns on both sides, and requiring improper fraction answers
- Forming and solving equations from worded problems (number puzzles, money-sharing problems)
- Ratio problems involving splitting quantities and finding unknown totals from given ratios
- Percentage profit calculations with multi-step reasoning
- Interior angles of regular polygons and angle properties at a point in tessellation problems

## How to use this paper for revision

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- Practise mental arithmetic with decimals and fractions so that you can work confidently without a calculator, particularly addition, subtraction, and simple multiplication of decimals.
- Revise the order of operations (BIDMAS) thoroughly and work through examples with nested brackets and powers; errors here cost marks in questions that are otherwise straightforward.
- When simplifying fractions, always cancel down fully and check whether your answer should be given as a mixed number; read the question carefully for instructions.
- For algebra questions, write every step of your working clearly. If you make an arithmetic error but your method is correct, you will still earn partial credit.
- In worded problems, define your variable (e.g. let Trudie's contribution = £x) before forming an equation. This makes your reasoning transparent to the examiner.
- Prime factorisation questions are often best approached using a factor tree; write factors in index form (e.g.  $3 \times 5 \times 7$ ) to avoid mistakes.
- For polygon angle questions, draw a clear diagram and label all known angles. Show how you calculate interior angles using the formula  $(n-2) \times 180^\circ \div n$ , where n is the number of sides.

## Common mistakes to avoid

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- Forgetting to follow the correct order of operations (BIDMAS) and working strictly left to right instead, leading to incorrect answers in Question 2.
- When dividing by a fraction, multiplying by the reciprocal incorrectly or forgetting to flip the second fraction, particularly in Question 3(d).
- In LCM and HCF problems, confusing which operation is needed: LCM for 'fit together' problems and HCF for 'splitting into equal groups' problems.
- Substituting negative values into algebraic expressions without using brackets, leading to sign errors (e.g. treating  $-4^2$  as 16 rather than recognising  $b^2 = (-4)^2 = 16$ ).
- Rushing through equation-solving and forgetting to perform the same operation to both sides, or losing track of negative signs when rearranging.
- In ratio problems, assuming the given numbers are the actual quantities rather than parts of a ratio, and failing to find the total number of parts first.

## Exam technique

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Begin by reading through the entire paper quickly to identify which questions you find most accessible. **Start with Question 1**, which tests straightforward arithmetic and will build your confidence, then work through the paper in order. If you become stuck on a multi-part question, move on and return to it later rather than spending too long on one part.

Allocate roughly **five minutes per question** on average, but be prepared to spend longer on Questions 9 to 12, which involve more complex reasoning and worded problems. Keep an eye on the clock and aim to complete at least ten questions within 50 minutes, leaving time to revisit difficult parts. Always show your working clearly, even for questions that seem straightforward; method marks can make the difference between a pass and a strong pass.

For the final geometry question (Question 12), note the explicit warning that answers without working will score few or no marks. Take time to draw a clear diagram, label the angles you calculate, and write out your reasoning in sentences or annotated steps. Even if you cannot reach the final answer, demonstrating that you understand how to calculate the interior angle of a decagon will earn partial credit.

## What to revise alongside this paper

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To consolidate your preparation, revise **properties of numbers** including squares, cubes, and prime numbers up to 100. Work on **algebraic manipulation** such as expanding brackets, factorising simple expressions, and solving simultaneous equations, which may appear in more advanced 13+ papers.

Practise further **problem-solving with ratio and proportion**, including direct and inverse proportion, best buys, and sharing in given ratios. These topics are commonly tested at 13+ and build naturally on the ratio questions in this paper. Geometry revision should extend to **angle properties in polygons**, circle theorems (where appropriate for the syllabus), and Pythagoras' theorem for right-angled triangles.

Finally, work on **worded problems** across all topics, as the ability to translate real-world scenarios into mathematical statements is a key skill assessed in entrance examinations. Timed practice with past papers will help you develop pacing and confidence under exam conditions.

## Key terms

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**Mean (average), BIDMAS / BODMAS, Improper fraction, Mixed number, Prime factorisation, Lowest common multiple (LCM), Highest common factor (HCF), Substitution, Simplify, Collecting like terms, Linear equation, Ratio, Percentage profit, Interior angle, Regular polygon, Decagon**

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**EXAMINATION PAPER**  
**13+ Academic Scholarship 2023**  
**Mathematics**  
**Paper 1**

**Time allowed: 1 hour**

**Name:** \_\_\_\_\_

**Instructions**

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- Write **ALL** your working and answers on this paper. Show enough working on each question to make it clear how you reached your answer.
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- You may work in pen or pencil.

**Question 1**

In a fishing competition an angler called Bob catches 5 fish, weighing:

1.75 kg, 1.4 kg, 0.98 kg, 3.6 kg, 2.7 kg

(a) What is the difference in weight between the biggest and smallest fish?

Answer .....

(b) What is the total weight of the five fish?

Answer .....

(c) Using your answer to (b), calculate the mean weight of the fish.

Answer .....

(d) The winner of the “heaviest fish” prize, Paul, caught a fish 2.8 times the weight of Bob’s heaviest catch. How heavy was the winning fish?

Answer .....

**Question 2** Work out the following, obeying the correct order of operations.

(a)  $4 + 6 \times 9 - 7$

Answer .....

(b)  $20 + 2 \times (10 - 3 \times 2)$

Answer .....

(c)  $4 \times 3^2 - (2 - 1)$

Answer .....

(d)  $8 + 7 - 4 + 3$

Answer .....

**Question 3** Calculate the following. Your answers should be fully simplified and written as a mixed number where appropriate.

(a)  $\frac{2}{5} + \frac{3}{4}$

Answer .....

(b)  $\frac{5}{12} - \frac{5}{16}$

Answer .....

(c)  $\frac{3}{22} \times \frac{14}{15}$

Answer .....

(d)  $\frac{7}{9} \div \frac{16}{21}$

Answer .....

**Question 4**

- (a) Write 105 as a product of its prime factors

Answer .....

- (b) List all of the factors of 105, in ascending order

Answer .....

**Question 5**

- (a) An event organiser is preparing for a conference. Each attendee will receive a pen and a pad of paper. Pens come in packs of 20 and pads of paper come in packs of 12. The organiser is able to order exactly the right number of packs of each, with no pens or pads left over. What is the smallest possible number of attendees?

Answer .....

- (b) A chocolatier has some left over chocolates which they decide to split into “bargain bags”. There are 24 dark chocolates, 32 milk chocolates and 16 white chocolates. Each bag must have identical contents, and all the chocolates must be used. What is the greatest number of “bargain bags” the chocolatier can make in this way?

Answer .....

**Question 6**

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(a)  $a - bc$

Answer .....

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Answer .....

(c)  $2(a + c) - 2b$

Answer .....

**Question 7** Fully simplify the following algebraic expressions

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Answer .....

(b)  $4x - 2x - 6 + x + 15$

Answer .....

(c)  $4xy - 7x + 2y + 3x$

Answer .....

(d)  $(2x)^2 \times 3xy$

Answer .....

**Question 8** Solve the following equations, leaving your answers as improper fractions where necessary.

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Answer .....

(b)  $\frac{2}{3}x - 4 = 10$

Answer .....

(c)  $5(2x - 7) = 15$

Answer .....

(d)  $7x - 8 = 12 - 3x$

Answer .....

(e)  $\frac{2x+3}{4} = 2$

Answer .....

(f)  $2x + \frac{3}{5} = \frac{1}{2}x - 3$

Answer .....

**Question 9**

For the following questions you must form and solve an equation.

- (a) I think of a number, add eighteen, then double the result; I now have 32.  
What was the number I thought of?

Equation .....

Solution .....

- (b) Ross, George and Trudie combine their savings to buy a toy costing £50. Ross contributes £5 more than Trudie, and George contributes three times more than Ross.  
How much did George contribute?

Equation .....

Solution .....

**Question 10**

Stan and Olivia bake 28 pies for market day; Stan bakes 8 more pies than Olivia.

- a) What is the ratio of the number of pies Stan bakes to the number of pies Olivia bakes?

Answer .....

The next week Stan and Olivia bake pies for market day again. Stan bakes 8 more pies than Olivia again, but this time the ratio of the number of pies Stan bakes to the number of pies Olivia bakes is 3:2.

- b) How many pies did they bake in total?

Answer .....

**Question 11**

Saul buys a guitar for £350, and later sells it to Gilbert for a 10% profit. Gilbert then sells the guitar to someone else and makes £11.20 more profit than Saul.

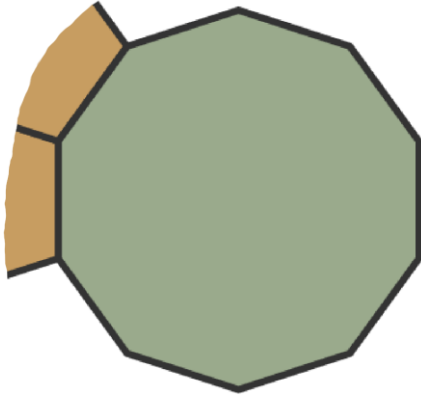
What percentage profit did Gilbert make on the guitar?

Answer .....

**Question 12**

A design for a sunflower is made using tiles; one, a decagon (forming the centre), surrounded by ten identical regular polygons (forming the petals). The diagram below shows part of the design. Calculate the number of sides of each of the “petals”.

*(answers without supporting working will receive few/no marks)*



Answer .....

# Paper Notes: 13+ Maths Question Paper (13+ Maths Past Paper (2023))

Compiled by [SATs-Papers.co.uk](https://www.SATs-Papers.co.uk) to help you get the most from this paper.

## Overview

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This is **Oundle School's 13+ Academic Scholarship Mathematics Paper 1**, sat in 2023. It is a non-calculator paper with a one-hour time limit, designed to assess candidates for academic scholarship places at **Year 9 entry**. The paper comprises twelve questions covering a broad range of topics from the KS3 mathematics curriculum, including arithmetic with decimals and fractions, order of operations, prime factorisation, lowest common multiples and highest common factors, algebraic manipulation, linear equations, ratio, percentage profit, and geometric reasoning with regular polygons.

The format is traditional written examination, requiring students to show full working on the paper itself. Marks are not stated per question, but the instruction to show working signals that method marks are awarded alongside answer marks. The questions range from straightforward retrieval (e.g. calculating a mean) through multi-step arithmetic and algebraic problems, to the final geometry challenge requiring angle reasoning and synthesis.

This paper suits students aiming at top independent schools with competitive scholarship programmes. It tests not only computational fluency but also problem-solving stamina, clear presentation of method, and the ability to form equations from worded scenarios.

## How this paper is organised

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The paper contains **twelve questions**, presented over nine pages including the cover sheet. Question 1 is split into four sub-parts focused on data handling with decimals. Questions 2 and 3 each comprise four sub-parts testing order of operations (Question 2) and fraction arithmetic (Question 3). Question 4 has two parts on prime factorisation and listing factors, while Question 5 has two parts on LCM and HCF in context.

Questions 6 and 7 address substitution into algebraic expressions and simplification respectively, each with multiple sub-parts. Question 8 presents six linear equations of increasing complexity, requiring students to solve and leave answers as improper fractions where necessary. Question 9 asks candidates to form and solve their own equations from word problems.

Questions 10, 11, and 12 are single-part problems of greater depth: Question 10 involves ratio with two related scenarios, Question 11 tests percentage profit across consecutive transactions, and Question 12 is a challenging geometry problem requiring angle calculation around a regular decagon. The rubric for Question 12 explicitly states that answers without supporting working will receive few or no marks, underlining the importance of clear reasoning throughout the paper.

## Topics covered

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- Arithmetic with decimals: addition, subtraction, range, and calculation of the mean
- Order of operations (BIDMAS/BODMAS) with brackets, exponents, multiplication, division, addition, and subtraction
- Fraction operations: addition, subtraction, multiplication, and division, with simplification to lowest terms and conversion to mixed numbers
- Prime factorisation of composite numbers and systematic listing of all factors
- Lowest common multiple (LCM) applied to real-world packing and distribution problems
- Highest common factor (HCF) in context: dividing quantities into identical groups
- Substitution of positive and negative integer values into algebraic expressions, including handling powers and fractions
- Simplification of algebraic expressions by collecting like terms and expanding brackets
- Solving linear equations: one-step, two-step, equations with brackets, equations with unknowns on both sides, and equations involving fractions
- Forming equations from worded problems: translating verbal descriptions into algebraic statements and solving
- Ratio: finding ratios from given information and using ratio to determine unknown quantities in related scenarios
- Percentage profit and loss: calculating percentage increase, chaining successive profit calculations, and reverse-engineering percentage changes
- Interior angles of regular polygons and angle reasoning around a tessellation of a regular decagon with identical regular pentagons

## How to use this paper for revision

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- Practise non-calculator arithmetic with decimals and fractions daily to build fluency and confidence, as mental and written methods are essential throughout this paper.
- Revise the order of operations thoroughly, including cases with nested brackets and repeated operations, and check your work by re-reading each line.
- Master the techniques for simplifying fractions and converting between improper fractions and mixed numbers; these skills underpin Question 3 and parts of Question 8.
- Learn the prime numbers up to at least 30 and practise factor trees so that prime factorisation becomes quick and reliable.
- Work through a variety of word problems involving LCM and HCF so you recognise when each method applies in context.
- Drill algebraic manipulation: collecting like terms, expanding brackets, and simplifying products of terms with indices, as these appear repeatedly in Questions 6, 7, and 8.
- Practise forming equations from written scenarios by identifying the unknown, translating phrases into algebraic expressions, and checking your equation against the problem statement before solving.
- Revise the interior angle formula for regular polygons and angle sums around a point, as Question 12 requires synthesis of both.

## Common mistakes to avoid

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- Forgetting to perform multiplication and division before addition and subtraction in order of operations questions, leading to incorrect final answers.
- Failing to find a common denominator when adding or subtracting fractions, or choosing an unnecessarily large common denominator that complicates simplification.
- Not fully simplifying fractions or forgetting to convert improper fractions to mixed numbers when the question requires it, losing marks for incomplete answers.
- Listing factors unsystematically and missing one or more, especially in the middle of the range; always work in pairs from 1 upwards.
- Confusing LCM and HCF in word problems: remember LCM for situations where cycles or packs align, HCF for dividing into equal groups.
- Making sign errors when substituting negative values into expressions, particularly when squaring or multiplying by a negative coefficient.
- Rushing through equation-solving and not checking both sides balance; always substitute your solution back into the original equation to verify.
- In the polygon question, attempting to calculate the petal polygon's sides without first determining the interior angle of the decagon and the angle available at each vertex.

## Exam technique

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Begin by reading the entire paper to gauge the range and difficulty of questions, then tackle them in order, as they are broadly sequenced from straightforward to challenging. Allocate roughly five minutes per question, leaving ten minutes at the end to attempt Question 12 and review your work. **Show all working clearly** and label intermediate steps; method marks are awarded even if your final answer is incorrect, and Question 12 explicitly penalises answers without supporting reasoning.

For multi-part questions, complete every sub-part before moving on, as earlier parts often provide values or insights needed later. In algebraic questions, write each manipulation on a new line and avoid skipping steps; examiners can only award marks for reasoning they can see. If a question asks for an answer as an improper fraction, do not convert it to a mixed number or decimal.

In the final ten minutes, return to any questions you skipped or found difficult, and check that you have answered what was asked (e.g. the question may ask for the ratio, not the individual quantities). For Question 12, sketch the tessellation if it helps, label the angles around the decagon's vertex, and set up an equation relating the interior angles

of the decagon and petal polygons. If time runs short, write down your method even if you cannot complete the arithmetic; partial credit is available for correct reasoning.

## What to revise alongside this paper

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To prepare fully for this paper, ensure fluency with KS2 and early KS3 number work: addition, subtraction, multiplication, and division of integers, decimals, and fractions without a calculator. Revise the rules of indices (positive integer powers) and how to apply them when simplifying algebraic terms. Strengthen your understanding of factors, multiples, and divisibility tests, as these underpin Questions 4 and 5.

Practise translating word problems into algebra and solving systems of simple equations if you want to extend your work on Question 9 and Question 10. Ratio and proportion problems appear frequently in 13+ papers, so work through additional examples involving scaling, division in given ratios, and comparing ratios across different scenarios.

For geometry, revise angle properties of polygons (interior and exterior angles, angle sums), angles around a point, and tessellations of regular shapes. If you found Question 12 challenging, explore problems involving angle reasoning at vertices where multiple polygons meet, as this skill appears in GCSE and olympiad papers alike.

## Key terms

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**Mean, Range, BIDMAS/BODMAS, Prime factor, Factor, Lowest common multiple (LCM), Highest common factor (HCF), Improper fraction, Mixed number, Simplify, Linear equation, Collecting like terms, Expanding brackets, Substitution, Ratio, Percentage profit, Regular polygon, Interior angle, Decagon, Tessellation**

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**EXAMINATION PAPER**  
**13+ Academic Scholarship 2023**

**Mathematics**  
**Paper 2**

**Time allowed: 2 hours**

**Name:** \_\_\_\_\_

**Instructions**

- Calculators are **NOT** allowed.
  - You **are** expected to answer all of Questions 1 – 6.
  - You **are not** expected to have time to answer all of Questions 7 – 14.
    - You may answer these questions in any order.
    - Choose those questions which you think you can answer best.
    - You may not need all the space provided to answer the question.
  - Remember to show your working and clearly show the method you are using in all questions.
-

**Question 1** Work out the following:

a)  $6.5 \times 4.32$

b)  $\sqrt{\frac{320}{0.002}}$

c)  $\frac{2+\frac{1}{2}}{3-\frac{1}{3}}$

d)  $167 \times 34 + 17 \times 66$

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**Question 2** Find the missing terms (?) in each of the following sequences:

a)  $-5, -3.5, -2, ?, ?, \dots$

b)  $18, 12, 8, 5\frac{1}{3}, ?, \dots$

c)  $3, 24, 81, ?, 375, \dots$

d)  $?, 1, \frac{2}{3}, \frac{1}{2}, \frac{2}{5}, ?, \dots$

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**Question 3** Simplify the following expressions fully:

a)  $4a + 3ab - 4b - a + 2b$

b)  $5x^2 - 2x(4 + 2x)$

c)  $63x^3 \div 9x^2$

d)  $6x - 4(2 + x) - (2x - 3)$

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**Question 4** If  $a = \frac{3}{4}$ ,  $b = -3$ , and  $c = 8$ , find the value of the following expressions. Leave your answers as simplified mixed numbers where necessary.

a)  $2a - 3b$

b)  $ac^2$

c)  $\frac{2c}{ab+3}$

d)  $\frac{4(2b+3)^2}{ac-2}$

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**Question 5** Solve the following equations:

a)  $\frac{3}{2x} - 7 = 0$

b)  $2x - 4 = \frac{x+6}{5} + 2$

c)  $x(x - 3) = 3(9 - x)$

d)  $4(x + 2) - 3(5 - 2x) = 7$

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**Question 6**

You are given that  $\frac{38 \times 27}{8.5 + 0.05} = 120$ .

Without doing lots of lengthy calculations, write down the values of:

a)  $\frac{0.38 \times 2.7}{8.5 + 0.05}$

b)  $\frac{38 \times 27}{850 + 5}$

c)  $\frac{19 \times 135}{85 + 0.5}$

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**Question 7**

Robert goes shopping and buys three shirts and a tie, costing a total of £53. After paying he changes his mind, so he returns the tie and buys an extra shirt instead. With the refund included, he only pays £7 in the second transaction.

Work out the individual cost of each shirt and each tie.

**Question 8**

Two normal six-sided dice, one coloured red and one coloured blue, have been modified. On the blue die the number 3 has been replaced by a 4, and on red die the number 4 has been replaced by a 3.

Both dice are thrown.

- a) What is the probability of rolling a 4 on the blue die and a 3 on the red die?
- b) What is the probability that the total on the two dice is an odd number?

**Question 9**

A small bakery bakes the same number of white and brown loaves of bread each day. On one day the bakery sells 120 white loaves and 160 brown loaves. At the end of the day the ratio of the unsold loaves was 5:3 (white : brown). How many loaves did they have at the start of the day?

**Question 10**

In a Six Nations Rugby match, the Irish team had a pack of 8 players whose mean weight was 102kg. In the second half 4 of these players, whose mean weight was 98kg, were replaced by 4 players whose individual weights were 96kg, 100kg, 108kg, and  $X$  kg. The mean weight of the pack of 8 players now rose to 104kg.

Find the value of  $X$ .

**Question 11**

It takes John 1 hour and 48 mins to clean the family car, and it takes Jane 1 hour and 12 mins.

- a) If John and Jane work together, how long would it take them to clean the family car?

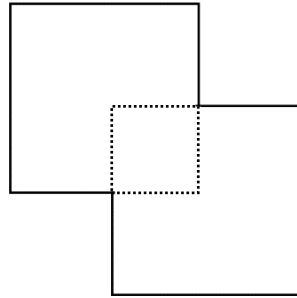
Richard drives his car 15 miles to the nearest automatic car wash. He drives at an average speed of 50mph.

- b) If Richard sets off at the same time that John and Jane start cleaning, and returns just as they finish, how long did the automatic car wash take?

**Question 12**

Two identical squares are overlapped to form an irregular octagon, as shown in the diagram below. The overlap also forms a square.

Given that the area of the overlap is  $\frac{2}{7}$  of the area of the octagon, what is the ratio of the perimeter of the octagon to the perimeter of one of the original squares?



**Question 13** You are given that  $2880 = 2^6 \times 3^2 \times 5$

a) Each factor of 2880 can be written using  $2^a \times 3^b \times 5^c$  ( $a$ ,  $b$ , and  $c$  **can** be zero;  $x^0 = 1$  for all  $x$ )

For instance:  $10 = 2^1 \times 3^0 \times 5^1$   
 $12 = 2^2 \times 3^1 \times 5^0$

- i) What would  $a$  equal if you were writing an odd factor in this way?
  - ii) How many values can  $b$  take?
  - iii) Without making a list, how many factors does 2880 have?
- b) Which has more factors,  $1,306,800 = 2^4 \times 3^3 \times 5^2 \times 11^2$  or  $636,245,792 = 2^5 \times 7^6 \times 13^2$ , and how many more?
- c) Write down, in index form, the power of 10 which has exactly 100 factors.

**Question 14**

In the addition problem below, each letter stands for a **different** digit (0 is never the first digit of any number).

$$\begin{array}{r} \text{T W O} \\ + \text{T W O} \\ \hline \text{F O U R} \end{array}$$

There are 7 solutions in total, but only one solution which **doesn't** contain the digit 8; find this solution.

# Paper Notes: 13+ Maths Question Paper (13+ Maths Past Paper (2023))

Compiled by [SATs-Papers.co.uk](https://www.SATs-Papers.co.uk) to help you get the most from this paper.

## Overview

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This is the **13+ Academic Scholarship Mathematics Paper 2** published by **Oundle School** in Northamptonshire for the 2023 entry cycle. It is designed to identify mathematically talented students applying for scholarship places at **Year 9 entry** (13+ level), and sits well above the standard entrance examination in difficulty and sophistication.

The paper is structured into two sections: a compulsory core (Questions 1 to 6) covering fundamental algebraic manipulation, arithmetic without calculators, and equation-solving, followed by a challenging extension bank (Questions 7 to 14) from which students choose the questions that play to their strengths. The extended questions explore probability, ratio problems, mean and weighted averages, rates of work, geometric reasoning, prime factorisation theory, and cryptarithmic puzzles. Calculators are **not permitted**, so all calculations must be done by hand or mentally.

This paper is intended for high-performing students aiming for scholarship recognition. The rubric explicitly states that candidates are **not expected to attempt every question** in the extension section, encouraging strategic selection and depth over breadth. The variety and depth of topics make this paper an excellent diagnostic tool for identifying gaps in problem-solving technique and mathematical reasoning.

## How this paper is organised

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The paper is divided into two distinct parts. **Questions 1 to 6** are compulsory and cover foundational skills: decimal and fraction arithmetic, simplifying algebraic expressions, substituting values into formulae, solving linear and quadratic equations, and using proportional reasoning to manipulate given numerical results. These questions are relatively short and expect concise answers, typically one or two lines of working.

The extension section, **Questions 7 to 14**, offers eight longer, more open-ended problems. Students are instructed to choose the questions they feel most confident tackling. Topics range from simultaneous equations presented as word problems (Question 7) and modified dice probability (Question 8) to calculating total quantities from ratios and differences (Question 9), finding unknown values using means and weighted totals (Question 10), combined work rates (Question 11), geometric reasoning

involving overlapping squares (Question 12), prime factorisation and factor-counting theory (Question 13), and a cryptarithmic addition puzzle (Question 14).

The paper allows **two hours** in total. The instructions emphasise showing clear working and method throughout. There is no published mark scheme within this document, so students should focus on demonstrating logical steps and justifying their answers fully.

## Topics covered

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- Decimal and fraction arithmetic without calculators, including products, square roots of fractions, and mixed-number division
- Algebraic simplification: collecting like terms, expanding brackets, dividing algebraic fractions with powers
- Substitution into algebraic expressions involving powers, fractions, and nested operations; simplifying results to mixed numbers
- Solving linear equations with fractions and unknowns on both sides; solving quadratic equations by factorisation or expansion
- Proportional reasoning and scaling: manipulating given calculations to find related values by adjusting numerators and denominators
- Simultaneous equations presented as real-world shopping problems with refunds and exchanges
- Probability with non-standard dice: calculating joint probabilities and summing outcomes for odd totals
- Ratio problems involving differences and totals: finding original quantities from end-of-day ratios and sales figures
- Weighted means and calculating unknown values: using total weight changes when subsets are replaced
- Combined work rates: finding the time taken when two people work together and calculating remaining time for additional tasks
- Geometric reasoning with overlapping squares: relating areas of overlap to perimeters using algebraic manipulation
- Prime factorisation and factor counting: using the formula  $(a+1)(b+1)(c+1)$  to count factors from prime decomposition
- Cryptarithmic puzzles: solving addition problems where letters represent distinct digits, subject to constraints

## How to use this paper for revision

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- Practise long multiplication and division by hand to build fluency, since calculators are forbidden and many questions require multi-step arithmetic with decimals and fractions.
- Revise the laws of indices thoroughly, particularly dividing powers and recognising patterns like  $2^a \times 3^b \times 5^c$ , which appear in prime factorisation questions.
- Work through simultaneous equations problems by setting up equations from word problems carefully, labelling unknowns clearly, and checking solutions make sense in context.
- For probability questions involving modified or non-standard scenarios, draw a sample space or list all outcomes systematically to avoid missing cases.
- Strengthen geometric reasoning by drawing diagrams, labelling sides with algebra, and writing down area or perimeter formulae explicitly before substituting.
- In cryptarithmic puzzles, start by identifying columns that must produce a carry, then narrow down possible digit values by testing constraints systematically.

## Common mistakes to avoid

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- Rushing decimal multiplication and making place-value errors; write out intermediate steps and line up decimal points carefully to avoid slips.
- Forgetting to apply the denominator when substituting into complex fractions; bracket all substituted values and simplify step by step.
- Expanding brackets incorrectly, especially when subtracting; distribute the negative sign across every term inside the bracket before collecting like terms.
- In probability, calculating individual probabilities correctly but forgetting to multiply for joint events or failing to identify all outcomes that satisfy 'the total is odd'.
- In ratio problems, confusing the ratio of unsold loaves with the ratio of total loaves; always relate the given ratio to the quantities you are asked to find.
- Misinterpreting 'mean weight rose to 104kg' as referring to only the new players rather than the entire pack of eight after substitutions.

## Exam technique

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Start with **Questions 1 to 6**, which are compulsory and generally shorter. Aim to complete these within the first 40 to 50 minutes, leaving over an hour for the extension questions. Show every step of your working, even for arithmetic, because marks are

awarded for method as well as final answers. If you make an error early in a multi-step question, clear working allows you to earn follow-through credit.

For **Questions 7 to 14**, scan the entire set first and identify two or three problems where you recognise the technique or feel confident about the approach. Do not attempt every question; the rubric explicitly states this is not expected. Choose depth over breadth: a fully correct, well-explained solution to one difficult problem is worth more than scrappy attempts at several. If you get stuck, move on and return later if time permits.

In multi-part questions, attempt every part even if you cannot solve an earlier one. Often later parts are independent or offer hints about the method. Check units, signs, and reasonableness of answers: a negative probability or a fraction greater than one should prompt you to revisit your working. Budget the final 10 minutes to review calculations and ensure you have answered what was asked.

## What to revise alongside this paper

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Students should revise **quadratic factorisation** and solving quadratics by completing the square or using the quadratic formula, as these techniques underpin Question 5(c) and similar problems. Strengthen understanding of **algebraic fractions**, including adding, subtracting, and simplifying expressions with unlike denominators, which builds confidence for substitution questions. Review **geometric properties of polygons**, particularly how to express perimeters and areas algebraically when shapes overlap or are transformed.

Beyond this paper, explore **number theory topics** such as highest common factors, lowest common multiples, and the relationship between prime factorisations and divisibility rules. These ideas extend the factor-counting question and appear frequently in senior scholarship papers. Practise **problem-solving under time pressure** by working through past UKMT Intermediate Mathematical Challenge or Team Maths Challenge problems, which develop similar reasoning skills and encourage strategic question selection.

For students aiming at scholarship level, consider investigating **combinatorics and counting principles**, which generalise the factor-counting approach, and **linear Diophantine equations**, which formalise the logic behind cryptarithmic puzzles. These topics provide a bridge to GCSE Further Maths and STEP-style problem solving.

## Key terms

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**Prime factorisation, Simultaneous equations, Weighted mean, Compound probability, Laws of indices, Algebraic substitution, Ratio and proportion, Combined work rate, Factor counting formula, Cryptarithmic, Octagon perimeter, Mixed numbers, Quadratic expansion, Non-standard dice, Sample space**

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