

## 13+ PAST PAPER PACK

# Oundle School 13+ Maths 2022

## Complete Past Paper Pack

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

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**EXAMINATION PAPER**  
**Junior Entry 2022**

**Mathematics**

**Time allowed: 1 hour**

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

**Instructions**

- Calculators are **NOT** allowed.
- Attempt all the questions.
- All working and answers must be shown on this paper. Marks will be given for demonstrating your method.

**Question 1**

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- (a) Andrew does his weekly grocery shop, which costs him £178.43. He stops in a cafe on the way home and buys a hot chocolate for £3.49 and a pastry for £1.25. How much has he spent in total?

Answer .....

- (b) Betty is making toast for a breakfast buffet at a large hotel. She has 27 loaves of bread, and each loaf is cut into 24 slices. How many slices of toast will this make?

Answer .....

- (c) Charlotte has collected 140 eggs from her chickens. She has 13 cartons which can hold 6 eggs each. How many more cartons will Charlotte need?

Answer .....

- (d) Dylan is looking to buy a new microwave. The one he wants costs £105.80 in a shop but is only £86.95 online. How much will he save by buying online?

Answer .....

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

(a)  $2 + 0 \times 22$

Answer .....

(b)  $2 + 0 \times 2 - 2$

Answer .....

(c)  $2 \times 0 \div 2 - 2$

Answer .....

(d)  $2 - (0 - 2) \times 2$

Answer .....

(e)  $2 + (0 - 2 \times 2)$

Answer .....

(f)  $20 \div (2 + 2) + 20 \times 22$

Answer .....

### Question 3

Insert brackets to make the following statements correct:

(a)  $3 \times 3 + 3 - 3 = 15$

(b)  $3 - 3 \div 3 + 3 \times 3 = 9$

**Question 4**

Given that  $123 \times 456 = 56088$ , write down the missing number in each part.

(a)  $12.3 \times ? = 56.088$

Answer .....

(b)  $? \times 4.56 = 560880$

Answer .....

(c)  $560.88 \div ? = 12300$

Answer .....

(d)  $246 \times 456 = ?$

Answer .....

(e)  $56088 \div ? = 369$

Answer .....

**Question 5**

You have the numbers  $-5$ ,  $3$ ,  $11$  and  $-6$  available.

Any of these numbers can be used in **each** part of the question, but only once per part.

(a) What is the greatest number that can be obtained by adding two of the above numbers?

Answer .....

(b) What is the greatest number that can be obtained by subtracting two of the above numbers?

Answer .....

(c) What is the least number that can be obtained by multiplying two of the above numbers?

Answer .....

(d) By replacing the missing numbers, what is the greatest value of this calculation?

$$? - ? \times ?$$

Answer .....

### Question 6

(a) Which fraction is bigger,  $\frac{4}{7}$  or  $\frac{6}{11}$ ?

Answer .....

(b) Write down a fraction which is greater than  $\frac{2}{11}$ , but less than  $\frac{3}{11}$ .

Answer .....

(c) Calculate  $\frac{2}{5} + \frac{3}{10}$ .

Answer .....

(d) Calculate  $\frac{3}{5} \times \frac{10}{21}$ , remembering to simplify your answer.

Answer .....

(e) What is the result if  $2\frac{1}{3}$  is taken from 4?

Answer .....

### Question 7

*In this question you may use the grid below to help you answer the questions.*

A straight line passes through the points (2, 1) and (8, 13).

(a) (i) The point  $(5, a)$  also lies on the line. Calculate the value of  $a$ .

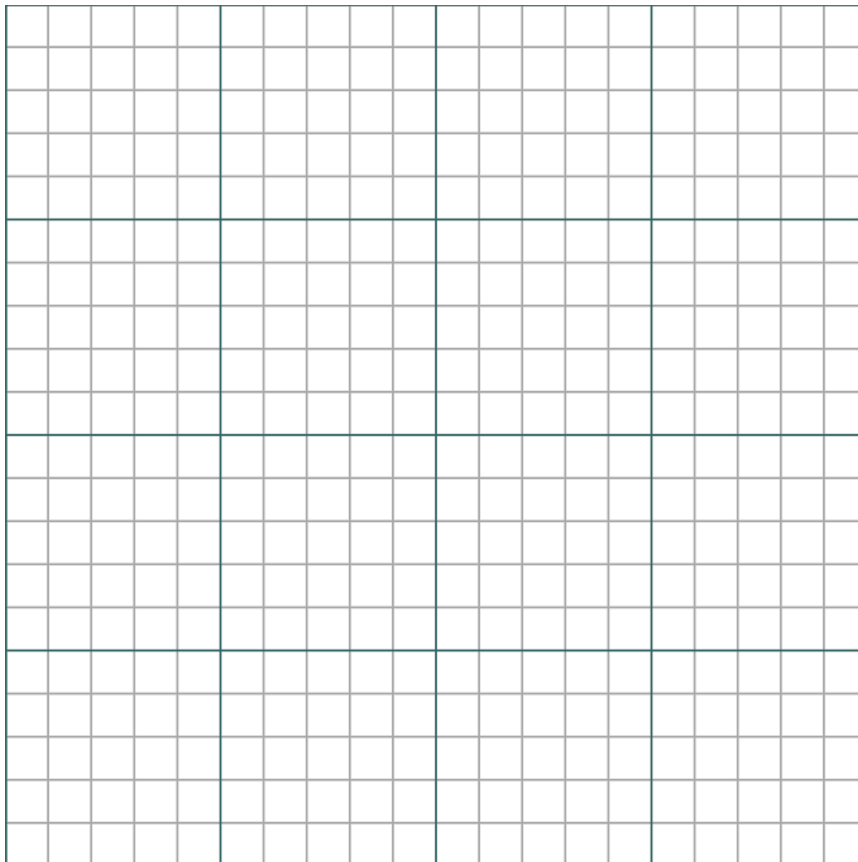
Answer .....

(ii) The point  $(b, 19)$  also lies on the line. Calculate the value of  $b$ .

Answer .....

(b) Another point  $(2, 10)$  forms a triangle with  $(2,1)$  and  $(8,13)$ . Find the area of the triangle.

Answer .....



**Question 8**

If it takes 3 dogs 5 hours to dig 12 holes, how many identical holes could 4 dogs dig in the same time?

Answer .....

**Question 9**

A shop sells cupcakes for £2.50 each. If you buy more than five cupcakes, the shop reduces the price to £2 for the additional cupcakes (but still full price for the first five). If you bought 20 cupcakes, what percentage saving would you have made?

Answer .....

**Question 10**

A school enters its pupils from Years 7 and 8 for a maths competition, in the ratio 2:5. There are 36 more Year 8s than Year 7s. How many pupils were entered in total?

Answer .....

**Question 11**

$m$  and  $n$  are two *different, positive* whole numbers which make the following statement true.

$$5m + 6n = 120$$

How many possible pairs of numbers make the statement above true?

Answer .....

**Question 12**

The symbol  $\textcircled{+}$  represents a mathematical operation which works as follows: find the sum of the two numbers and divide by their product, leaving you answer as a fraction (which may be simplified).

ie.  $5 \otimes 7 = \frac{5+7}{5 \times 7}$

$$= \frac{12}{35}$$

For each part, write down the missing value.

(a)  $4 \otimes 9 = ?$

Answer .....

(b)  $7 \otimes ? = \frac{15}{56}$

Answer .....

(c)  $? \otimes 6 = \frac{1}{2}$

Answer .....

(d) Find a pair of positive whole numbers,  $a$  and  $b$ , for which:

(i)  $a \otimes b = 1$

Answer .....

(ii)  $a \otimes b - \frac{a}{b} = 0$

Answer .....

# Paper Notes: 13+ Maths Question Paper (13+ Maths Past Paper (2022))

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 Junior Entry 2022 Mathematics** examination paper, designed for candidates sitting the **13+ entrance exam** for Year 9 entry. The paper is intended to assess mathematical competence across a broad range of topics, from arithmetic and number work through to coordinate geometry, fractions, and problem-solving.

Students have **one hour** to complete the paper, and **calculators are not allowed**. All working must be shown on the paper itself, and marks are awarded for demonstrating method as well as obtaining correct answers. This format rewards clear, logical reasoning and the ability to communicate mathematical thinking.

The paper is suitable for pupils in Year 8 preparing for independent or grammar school entrance. It covers core topics from the Key Stage 3 curriculum and tests both fluency and the ability to apply knowledge in unfamiliar contexts. The questions progress from straightforward calculations to multi-step problems requiring deeper understanding.

## How this paper is organised

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The paper consists of **12 questions** ranging from short calculations to longer, multi-part problems. Question 1 comprises four real-world word problems involving money and quantities. Questions 2 and 3 focus on the order of operations (BIDMAS), including inserting brackets to make statements correct.

Question 4 tests understanding of decimal multiplication and division, while Question 5 explores operations with negative numbers. Question 6 covers fractions (comparing, ordering, adding, multiplying, and mixed numbers). Question 7 involves coordinate geometry and finding the area of a triangle.

Questions 8 to 12 present more complex problem-solving scenarios: proportional reasoning (dogs digging holes), percentage discounts, ratio problems, solving linear equations, and a novel operation defined by the examiner. A grid is provided for Question 7. The layout is clean, with space for working beneath each part.

## Topics covered

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- Addition and subtraction of money (decimal arithmetic)
- Multiplication and division of whole numbers in real-world contexts
- Order of operations (BIDMAS/BODMAS) with brackets, multiplication, division, addition, and subtraction
- Inserting brackets to create correct equations
- Decimal multiplication and division using known integer results
- Operations with negative numbers (addition, subtraction, multiplication)
- Comparing, ordering, adding, multiplying, and simplifying fractions
- Converting and calculating with mixed numbers
- Coordinate geometry: finding points on a line given two known coordinates
- Area of a triangle using coordinates
- Proportional reasoning and ratio problems
- Percentage calculations and discounts in multi-step problems
- Solving linear Diophantine equations (finding integer solutions to equations)
- Understanding and applying novel mathematical operations defined by the examiner

## How to use this paper for revision

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- Practise BIDMAS questions daily, particularly those involving brackets and multiple operations, to build speed and accuracy under time pressure.
- Revise fractions thoroughly: make sure you can add, subtract, multiply, and divide fractions confidently, and always simplify your final answers.
- Work on coordinate geometry problems by sketching axes and plotting points, which helps visualise the relationship between coordinates and gradients.
- Strengthen your mental arithmetic and times tables so you can work efficiently without a calculator.
- Read word problems carefully twice before starting. Underline key numbers and decide what operation is needed before calculating.
- When working with negative numbers, use a number line to visualise addition and subtraction if you find signs confusing.
- For ratio problems, draw bar models or write out the parts clearly to avoid mistakes when scaling up or finding totals.

## Common mistakes to avoid

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- Ignoring the order of operations and working strictly left to right, leading to incorrect answers in Questions 2 and 3.
- Forgetting to simplify fractions fully, especially in Question 6(d), where cancelling common factors is essential.
- Misreading word problems and picking the wrong operation, such as dividing when multiplication is required in Question 1(b).
- Placing the decimal point incorrectly when scaling multiplication or division problems in Question 4.
- Confusing subtraction with negative numbers: for example, thinking 11 minus (-6) equals 5 instead of 17 in Question 5(b).
- Rushing through ratio problems and forgetting that the ratio represents parts, not the actual totals.

## Exam technique

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Start by reading through the entire paper quickly to identify questions you can answer immediately and those requiring more thought. Tackle the easier questions first (Questions 1, 2, and parts of Question 6) to build confidence and secure straightforward marks.

Allocate roughly five minutes per question, adjusting for multi-part problems. Show all working clearly, even for calculations you can do mentally, because **method marks** are awarded. If you are stuck on a multi-part question, attempt the parts you can and move on rather than losing time.

In the final ten minutes, return to any questions you skipped and check your answers. Look especially at Questions 4 and 12, where careful manipulation of numbers and operations is crucial. Use any spare time to double-check decimal places, negative signs, and simplified fractions.

## What to revise alongside this paper

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Students should revise **algebraic manipulation**, particularly solving simple linear equations and rearranging formulae, as Question 11 tests systematic substitution and logical reasoning. Practise **proportional reasoning** and **ratio problems** in various contexts (recipes, speeds, quantities) to prepare for Questions 8 and 10.

Coordinate geometry skills can be extended by studying **gradients, midpoints, and distance between points**, all of which appear in 13+ and early GCSE papers.

Strengthen problem-solving by working through multi-step word problems from past papers and practice books, focusing on extracting information and choosing efficient methods.

For pupils aiming at top independent schools, explore **algebraic problem-solving**, **geometrical reasoning** (angles, polygons, area and perimeter), and **harder percentage and ratio questions** to build confidence beyond the core curriculum.

## Key terms

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**BIDMAS, Order of operations, Decimal multiplication, Negative numbers, Fraction simplification, Mixed numbers, Coordinate geometry, Gradient, Linear equation, Ratio, Proportion, Percentage discount, Diophantine equation, Product, Integer solutions**

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For more free 11+ practice papers, past papers and online practice tests, visit [SATs-Papers.co.uk](https://www.SATs-Papers.co.uk).



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**EXAMINATION PAPER**  
**Non Common Entrance 2022**

**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. It is far better to have completed a small number of questions well than to have only begun lots of questions.
- You may work in pen or pencil.

**Question 1**

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A gold prospector finds three gold nuggets weighing 1.54g, 0.87g, and 1.704g.

(a) What is the total weight of the three nuggets?

Answer .....

(b) What is the difference in weight between the biggest and smallest nuggets?

Answer .....

(c) If gold sells for £43 per gram, how much is the smallest nugget worth?

Answer .....

(d) An ounce is approximately 28 grams. Convert the weight of the 1.54g nugget into ounces.

Answer .....

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

(a)  $3 + 5 \times 8 - 6$

Answer .....

(b)  $10 - (20 - 8) \div 2$

Answer .....

(c)  $24 \div (16 - 4 \times 2)$

Answer .....

(d)  $100 - 80 - (60 - 40)$

Answer .....

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

(a)  $2\frac{1}{5} + 1\frac{3}{4}$

Answer .....

(b)  $4\frac{2}{7} - 2\frac{5}{14}$

Answer .....

(c)  $2\frac{2}{9} \times 4\frac{1}{5}$

Answer .....

(d)  $1\frac{3}{8} \div 4\frac{2}{5}$

Answer .....

**Question 4**

(a) Write down the prime factorisation of 60.

Answer .....

(b) List all of the factors of 60, in ascending order.

Answer .....

**Question 5**

(a) Hotdogs come in packs of 10 and buns come in packs of 6; each bun holds one hotdog. What is the smallest number of packs of each you would need to buy if you didn't want any left-over hotdogs or buns?

Packs of hotdogs.....

Packs of buns.....

(b) A group of 20 boys and 24 girls are going to be split into even teams. Each team must contain the same number of boys and girls. What is the maximum number of teams which can be made in this way?

Answer .....

**Question 6**

If  $a = 4$ ,  $b = 3$  and  $c = -5$ , find the value of the following expressions.

(a)  $a + bc$

Answer .....

(b)  $ab^2$

Answer .....

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

Answer .....

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

(a)  $4a + 2b - a + 6b$

Answer .....

(b)  $2x + 4x + 6 - x - 12$

Answer .....

(c)  $3x^2 + 2x + y - 4x$

Answer .....

(d)  $7x \times 2xy$

Answer .....

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

(a)  $5x - 8 = 27$

Answer .....

(b)  $\frac{3x}{5} + 4 = 6$

Answer .....

(c)  $4(3x - 5) = 10$

Answer .....

(d)  $8 - 2x = 10x - 4$

Answer .....

(e)  $15 - 4x = 1$

Answer .....

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

Answer .....

**Question 9**

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

- (a) I think of a number, subtract seven, then treble the result; I now have 27.  
What was the number I thought of?

Equation .....

Solution .....

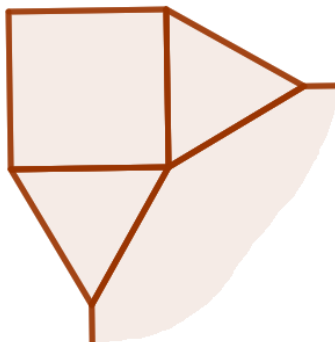
- (b) John has twice as many marbles as Kelly. Beth has five fewer marbles than Kelly. Between the three of them they have a total of 27 marbles.  
How many marbles does John have?

Equation .....

Solution .....

**Question 10**

A square, two equilateral triangles, and one other regular polygon are placed together as shown in the *incomplete* diagram below.



(a) What is the interior angle of an equilateral triangle?

Answer .....

(b) Calculate the interior angle of the incomplete regular polygon. You should give an angle reason to justify your answer.

Answer .....

(c) Calculate the number of sides that the incomplete regular polygon has.

Answer .....

**Question 11**

Godfrey has a four-digit combination lock which uses the digits 1-9. He writes down some clues in case he forgets what the correct combination is:

- the mean of the digits is 4.75.
- the range of the digits is 8.
- two of the digits are prime numbers.
- if the digits are put in ascending order,  $a < b < c < d$ , then the correct order is  $a, c, b, d$ .

Find Godfrey's combination.

Answer .....

# Paper Notes: 13+ Maths Question Paper (13+ Maths Past Paper (2022))

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 Non Common Entrance 2022 Mathematics paper**, a one-hour examination designed for **13+ entry** (Year 9) candidates applying to the school. The paper tests a broad range of mathematical topics at a level typical of end-of-Year 8 or early-Year 9 content, covering arithmetic with decimals, order of operations, fractions (including mixed numbers and all four operations), factors and prime factorisation, lowest common multiples and highest common factors, algebra (substitution, simplification, equation solving), geometry (interior angles of polygons), and problem-solving with constraints (such as the combination lock puzzle).

The paper consists of **11 questions** with multiple parts, and calculators are **not permitted**. Students are expected to show all working clearly on the paper itself, which is typical of selective independent school entrance examinations. The format is predominantly free-response, requiring students to demonstrate full methods rather than simply circle answers.

This paper is well-suited to students preparing for **13+ entrance exams** at academically selective independent schools, particularly those who have completed or nearly completed the Key Stage 3 curriculum. The difficulty and breadth of content make it a strong revision tool for assessing readiness across core mathematical skills.

## How this paper is organised

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The paper is organised into **11 questions**, each with between one and six sub-parts labelled (a), (b), (c), and so on. The total examination time is **one hour**, and no calculator is allowed. The marks for individual questions are not stated on the paper, though the variety and length of questions suggest that later questions (such as the polygon geometry in Question 10 and the combination lock puzzle in Question 11) likely carry more weight.

Question 1 focuses on decimal arithmetic and unit conversion, while Questions 2 and 3 move through order of operations and fraction calculations. Questions 4 and 5 address number properties (prime factorisation, factors, LCM, and HCF), and Questions 6 and 7 test algebraic substitution and simplification. Question 8 contains six equations of increasing difficulty, and Question 9 requires students to form and solve equations from word problems.

Questions 10 and 11 are more extended and conceptual: Question 10 involves calculating interior angles of regular polygons and determining the number of sides from the angle sum, while Question 11 is a logic puzzle requiring careful application of mean, range, and ordering constraints. The layout is clear, with ample space provided for working beneath each sub-question.

## Topics covered

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- Decimal addition, subtraction, and multiplication in context (gold nugget weights and currency conversion)
- Order of operations (BIDMAS/BODMAS) with brackets, division, multiplication, addition, and subtraction
- Addition, subtraction, multiplication, and division of mixed numbers and fractions, with simplification required
- Prime factorisation using factor trees or repeated division (specifically for 60)
- Listing all factors of a composite number in ascending order
- Lowest common multiple (LCM) applied to real-world contexts (hotdogs and buns problem)
- Highest common factor (HCF) used to solve equal-sharing problems (splitting boys and girls into teams)
- Substitution into algebraic expressions involving positive and negative integers
- Simplification of algebraic expressions by collecting like terms and multiplying algebraic terms
- Solving linear equations including those with brackets, fractions, and unknowns on both sides
- Forming and solving equations from word problems (think-of-a-number and marble-sharing contexts)
- Interior angles of regular polygons, including equilateral triangles and calculation from angle sums at a point
- Using the interior angle formula to determine the number of sides of a regular polygon
- Logic and problem-solving involving mean, range, prime numbers, and ordering constraints (combination lock puzzle)

## How to use this paper for revision

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- Practise decimal arithmetic without a calculator, particularly adding and subtracting numbers with different numbers of decimal places by aligning the decimal points carefully.
- Memorise the order of operations (BIDMAS: Brackets, Indices, Division/Multiplication, Addition/Subtraction) and work through multi-step examples to build confidence.
- Review how to convert mixed numbers to improper fractions and vice versa, and ensure you can find common denominators quickly for fraction addition and subtraction.
- Revise prime factorisation methods (factor trees or division ladders) and be able to list all factors of a number systematically by pairing factors.
- Understand the difference between LCM and HCF and practise applying each to word problems, identifying which is needed from the context.
- Work through substitution problems with negative numbers, taking care with signs when squaring or multiplying negative values.
- Practise forming equations from word problems by identifying the unknown, translating sentences into algebraic expressions, and solving step-by-step with clear working.

## Common mistakes to avoid

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- Forgetting to apply BIDMAS correctly and performing operations from left to right without considering brackets or multiplication/division priority, leading to incorrect answers in Question 2.
- Leaving fraction answers unsimplified or as improper fractions when the question asks for a mixed number, or forgetting to convert before adding/subtracting fractions with different denominators.
- Confusing LCM and HCF in word problems, for example using HCF when the problem requires finding the smallest shared multiple (as in the hotdog and bun question).
- Making sign errors when substituting negative values into expressions, especially forgetting that squaring a negative gives a positive result (Question 6b).
- Incorrectly distributing when expanding brackets in equations (Question 8c) or failing to multiply every term inside the bracket by the factor outside.
- Rushing through logic puzzles like Question 11 without systematically checking all constraints, leading to combinations that satisfy some clues but not others.

## Exam technique

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Allocate your time carefully across the **11 questions in one hour**. Aim to spend no more than five to six minutes per question on average, leaving time at the end to review your answers. Start with the questions you find most straightforward (likely Questions 1 to 3 on arithmetic and fractions) to build confidence and secure marks quickly, then move to algebra and problem-solving questions.

For multi-part questions, if you are stuck on one sub-part, move to the next rather than losing time. Each part is often independent, so you can still earn marks elsewhere. In Questions 8 and 9, show every step of your working clearly, particularly when solving equations or forming them from word problems, as partial credit is often awarded for correct method even if the final answer is wrong.

In extended questions like Question 10 (polygons) and Question 11 (combination lock), write down all your reasoning and intermediate calculations. For the polygon question, state your angle reason explicitly (e.g. 'angles at a point sum to 360 degrees'). For the logic puzzle, list the constraints and test possible digit combinations systematically. If you finish early, double-check your arithmetic in Questions 1 and 3, as small errors with decimals or fractions are common under time pressure.

## What to revise alongside this paper

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Students should revise **percentages and ratio** alongside this paper, as these are closely related to fraction work and often appear in 13+ papers. Review how to convert between fractions, decimals, and percentages, and practise solving ratio problems involving sharing and scaling. Strengthen your understanding of **indices and powers**, including the laws of indices, as these underpin algebraic multiplication and will appear in more advanced algebra questions.

To build on the geometry in Question 10, study **angle properties of parallel lines, triangles, and quadrilaterals**, and practise calculating exterior angles of polygons using the formula  $360 \div n$ . For students aiming at the most competitive independent schools, explore **simultaneous equations** and basic **quadratic expressions**, which extend the algebraic skills tested here.

Finally, practise more **logic and reasoning puzzles** similar to Question 11, as these test mathematical thinking and problem-solving under constraints. Resources such as UKMT Junior Maths Challenge papers and similar non-routine problems will help develop this skill.

## Key terms

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**BIDMAS / BODMAS, Improper fraction, Mixed number, Prime factorisation, Lowest common multiple (LCM), Highest common factor (HCF), Substitution, Like terms, Simplify, Linear equation, Interior angle, Regular polygon, Equilateral triangle, Mean, Range**

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**EXAMINATION PAPER**  
**Academic Scholarship 2022**

**Mathematics – Paper 1**

**Time allowed: 90 minutes**

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

**Instructions**

- Calculators are **NOT** allowed.
- Please write your answers on lined paper.
- You are not expected to have time to do all the questions.
- You may answer the questions in any order
- Choose those questions which you think you can answer best.
- Remember to show your workings and clearly show the method you are using.
- Give answers to 3 significant figures where necessary.

**Question 1** Work out the following:

- a)  $0.03 \times 4.5$
- b)  $8 \div 1\frac{4}{5}$
- c) 24% of 155
- d)  $\sqrt{40000}$
- e)  $16 \times 78 - 12 \times 39$

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

- a)  $-7, -3, 1, 5, ?, \dots$
- b)  $12, 6, 3, ?, \dots$
- c)  $2, 8, 18, ?, 50, \dots$
- d)  $?, \frac{3}{8}, \frac{4}{27}, \frac{5}{64}, \dots$

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

- a)  $7xy - 4x + 2y + x - 3yx$
- b)  $3x + 2(3x - 7) - (5 - x)$
- c)  $140x^3 \div 35x^2$
- d)  $8x + 3x^2 - 4x(x - 2)$

**Question 4** If  $a = \frac{2}{3}$ ,  $b = -0.5$ , and  $c = 6$ , find the value of:

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

**Question 5** Solve the following equations:

a)  $\frac{2}{x} - 5 = 0$

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

c)  $x(x - 2) = 16 - 2x$

**Question 6** Solve for  $x$  and  $y$

$$\begin{aligned}y &= 2x + 7 \\ 3x - 2y &= -13\end{aligned}$$

**For the remaining questions, you should show full working which clearly shows how you arrived at your answer.**

**Question 7**

Jane buys a painting and a vase from an antiques shop for a total of £42. She later sells both items for an overall profit of 25%. She sold the vase for £25.50, which represented a 50% profit. What was the percentage profit on the painting?

**Question 8**

Bill and Ben each have some marbles in the ratio 3:5. Ben trades a quarter of his marbles for 2 of Bill's. They now have an equal number of marbles; how many marbles do they have in total?

**Question 9**

Two identical dice, with the numbers  $-3, -2, -1, 0, 1, 2$  on the faces, are rolled and the two numbers on the top faces are recorded.

- What is the probability that the **product** of the two numbers is negative?
- What is the probability that the **sum** of the two numbers is negative?
- What is the probability that the product and the sum of the two numbers are both negative?

### Question 10

Charlotte picks 5 positive integers which have a:

- Mean of 5
- Mode of 3
- Range of 7

- a) Find the three possible sets of numbers that Charlotte could have picked.
- b) Charlotte swaps one of her numbers for another positive integer. The mean is now 6 but there is no mode. Which of the three possible sets of numbers did Charlotte originally pick?

### Question 11

Alice's car display records her average speed for each journey. On one journey she has been driving for 30mins and her average speed is 40mph. Alice stops at a set of traffic lights; when she sets off again the display now shows that her average speed is 32mph.

- a) How long was Alice stopped at the lights? Give your answer in minutes and seconds.

Alice is now driving at a constant speed of 60mph.

- b) How long does Alice need to drive at this speed to increase her average speed for the journey to 40mph again?

### Question 12

On an analogue clock the hour and minute hands move smoothly, so that each is moving around the dial at a constant rate.

- a) Through how many degrees does each hand move every minute?

At 3 o'clock the hour and minute hands are at right angles to each other.

- b) What is the acute angle between the hour and minute hands at half past 3?
- c) How long after half past 3 will the hands next be at right angles again? Give your answer to the nearest minute.

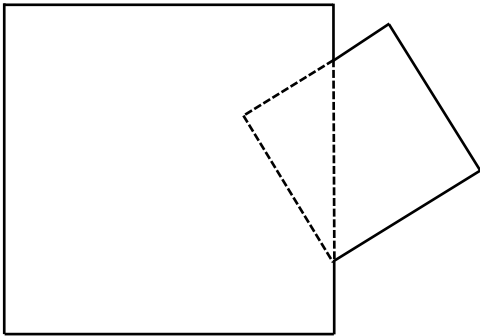
### Question 13

$$\begin{aligned}3^1 &= 3 \\3^2 &= 9 \\3^3 &= 27 \\3^4 &= 81\end{aligned}$$

- Write down the units digits of  $3^5$  and  $3^6$ .
- What would the units digit of  $3^{333}$  be?
- What is the units digit of the number equal to  $1^1 + 2^{22} + 3^{333} + 4^{4444} + 5^{55555}$  ?

### Question 14

Two squares are overlapped to form an irregular octagon, as shown in the diagram, with one corner of the smaller square lying on the side of the larger one. The larger square has sides of  $10\text{cm}$  and the smaller one has sides of  $4\text{cm}$ .



The area of the overlap is  $6\text{cm}^2$ .

- Find the area of the octagon.
- Find the perimeter of the octagon.

# Paper Notes: 13+ Maths Question Paper (13+ Maths Past Paper (2022))

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 Academic Scholarship Mathematics Paper 1** from **2022**, designed for candidates sitting the **13+ entrance examination** for Year 9 entry. Oundle School is an independent co-educational boarding and day school in Northamptonshire, and this paper forms part of their scholarship assessment process for mathematically talented students.

The paper contains **14 questions** covering a broad range of mathematical topics, from foundational arithmetic and algebra through to more challenging problem-solving scenarios involving probability, geometry, averages, and number patterns. The format mixes straightforward calculation questions with extended multi-part problems that demand clear reasoning and full working. Students are explicitly told they are **not expected to complete all questions** and should select those they can answer best.

The 90-minute time limit and the scholarship context make this paper suitable for able Year 8 students preparing for competitive 13+ entrance or scholarship exams at selective independent schools. **Calculators are not permitted**, so fluency with mental arithmetic, fractions, and algebraic manipulation is essential. The instruction to answer to three significant figures where necessary signals that some questions involve approximation and decimal work.

## How this paper is organised

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The paper is divided into two distinct sections. **Questions 1 to 6** form the foundational section, testing core skills in arithmetic, sequences, algebraic simplification, substitution, and equation solving. These questions are broken into multiple short parts (a, b, c, etc.), allowing candidates to demonstrate breadth across fundamental topics. Each part typically requires a single calculation or manipulation.

From **Question 7 onwards**, the paper shifts to extended problem-solving questions that require full working and clear explanation. These questions draw on real-world contexts (antiques profit, marble trades, car journey speeds, clock hands, overlapping shapes) and demand multi-step reasoning. The rubric before Question 7 explicitly reminds students to show how they arrived at their answer, signalling that method marks will be available.

The paper carries **no visible mark allocation** printed alongside individual questions, though the scholarship context suggests that later questions are likely weighted more heavily. The instruction that students may answer questions in any order and should choose those they can answer best reflects the selective nature of the assessment, where demonstrating depth on some questions is valued over breadth across all.

## Topics covered

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- Arithmetic operations with decimals, mixed numbers, and percentages (multiplication, division, square roots)
- Number sequences including arithmetic progressions, geometric sequences, and pattern spotting with algebraic terms
- Algebraic simplification involving like terms, expansion of brackets, and division of algebraic fractions
- Substitution into algebraic expressions with fractional, decimal, and negative values
- Solving linear and quadratic equations, including rearrangement and factorisation
- Simultaneous equations solved by substitution or elimination
- Multi-step percentage profit and loss problems with combined totals
- Ratio problems involving change and equalisation of quantities
- Probability with non-standard dice and combined events (product and sum conditions)
- Statistical measures (mean, mode, range) with constrained data sets and logical deduction
- Average speed, distance, and time calculations with stationary periods and variable speeds
- Angle measurement and clock hand problems involving rates of movement
- Cyclical patterns in powers and modular arithmetic (units digits)
- Geometric reasoning with overlapping shapes, area, and perimeter of composite figures

## How to use this paper for revision

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- Revise multiplying and dividing decimals without a calculator, particularly by converting to fractions or using place value partitioning to keep track of digits.
- Practise spotting sequence types quickly: arithmetic (constant difference), geometric (constant ratio), and quadratic or cubic patterns based on position number.
- When simplifying algebra, collect like terms carefully and watch for sign errors when expanding brackets or subtracting expressions in parentheses.
- For substitution questions, write out the expression with brackets around each substituted value to avoid mistakes with negative numbers and fractions.
- In multi-step word problems, define variables clearly at the start and set up equations systematically before attempting to solve.
- For probability questions with custom dice, draw a sample space grid to list all 36 outcomes and count favourable cases methodically.
- Review how to work backwards from statistical measures: if you know the mean, mode, and range, set up equations for the unknowns and test small integer values.

## Common mistakes to avoid

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- Mishandling negative numbers in sequences or substitution, particularly when squaring or multiplying negative values (forgetting that the square of a negative is positive).
- Confusing the order of operations in mixed arithmetic expressions, especially when subtracting products (e.g. treating  $16 \times 78 - 12 \times 39$  as  $(16 \times 78 - 12) \times 39$ ).
- Forgetting to show full working in the extended questions from Question 7 onwards, which loses method marks even if the final answer is correct.
- Over-complicating ratio problems by not translating the ratio into actual quantities early, leading to algebraic muddles when changes are introduced.
- In probability, counting ordered pairs incorrectly or forgetting that rolling two dice gives 36 equally likely outcomes, not 21.
- Assuming the mode must be unique in statistics questions, when multiple values can share the highest frequency or no mode exists.

## Exam technique

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Allocate your time strategically across the paper. The first six questions test core skills and should be completed relatively quickly, leaving around 50 to 60 minutes for the extended problems. Read each question fully before starting and identify which ones

play to your strengths. Because you are not expected to finish, aim to answer six or seven questions thoroughly rather than rushing through all fourteen with incomplete working.

In the extended questions, lay out your method step by step. Define any variables you introduce, write intermediate results clearly, and box or underline final answers. If a question asks for an answer in specific units (e.g. minutes and seconds, or to the nearest minute), make sure you convert and round appropriately. Marks are awarded for method, so even if you make an arithmetic slip, a clear logical path will earn credit.

If you get stuck on a multi-part question, attempt the earlier parts and move on. Often part (a) is accessible even if part (b) requires a deeper insight. Check your working as you go, particularly with negatives, fractions, and brackets. In the final minutes, revisit any questions where you wrote an answer but did not show full working, and add brief explanatory steps to secure method marks.

## What to revise alongside this paper

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Students preparing for this paper should be confident with all GCSE foundation-tier algebra and number work, including manipulating expressions, solving equations, and working with indices. Ratio and proportion problems at this level often involve setting up and solving simultaneous equations, so fluency with both substitution and elimination methods is important.

Probability questions frequently test systematic listing and counting, so practise drawing sample space diagrams and using tree diagrams for combined events. Geometry topics such as angle properties, circle theorems, and composite area and perimeter problems appear regularly in scholarship papers. Revisit Pythagoras's theorem and basic trigonometry if the paper extends to spatial reasoning.

For students aiming at scholarship level, explore extension topics such as sequences defined recursively, modular arithmetic (useful for cyclic patterns in powers), and logical reasoning puzzles involving constraints. Familiarity with problem-solving techniques like working backwards, testing small cases, and checking for patterns will help in tackling the later questions confidently.

## Key terms

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**Arithmetic progression, Geometric sequence, Algebraic simplification, Substitution, Quadratic equation, Simultaneous equations, Percentage profit, Ratio, Probability, Sample space, Mean, Mode, Range, Average speed, Composite figure, Perimeter, Area, Units digit, Powers of 3, Modular arithmetic**

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**EXAMINATION PAPER**  
**Academic Scholarship 2022**

**Mathematics – Paper 2**

**Time allowed: 2 hours**

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

**Instructions**

- Calculators are **NOT** allowed.
- Please write your answers on lined paper.
- You are not expected to have time to do all the questions.
- You may answer the questions in any order
- Choose those questions which you think you can answer best.
- Remember to show your workings and clearly show the method you are using.
- Give answers to 3 significant figures where necessary.

## Question 1

A “mathemagician” is performing a “mind-reading” trick. He picks a random member of the audience and hands them a sealed envelope. He tells the “volunteer” to:

1. choose a number:

He hands over a calculator, just to make sure the volunteer doesn't make a calculation error, and then says:

2. add 29 to your number
3. double the result
4. now subtract 8
5. multiply the result by 10
6. let's add 340 to that number
7. times by 5
8. divide what you've got by 100
9. take away the number you first thought of

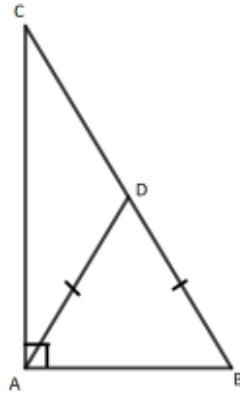
The mathemagician asks the volunteer, “what is the number on the calculator screen?”, to which the response is “42”. The mathemagician tells the volunteer to now open the sealed envelope; the card in the envelope has the number 42 printed in gold lettering; the audience is amazed!

Copy and complete the table below to show how the trick works:

| Instruction                                  | Simplified expression |
|--|-----------------------|
| 1. choose a number                           | $x$                   |
| 2. add 29 to your number                     |                       |
| 3. double the result                         |                       |
| 4. now subtract 8                            |                       |
| 5. multiply the result by 10                 |                       |
| 6. let's add 340 to that number              |                       |
| 7. times by 5                                |                       |
| 8. divide what you've got by 100             |                       |
| 9. take away the number you first thought of | 42                    |

### Question 2

The diagram below shows a right-angled triangle  $ABC$ , with  $\hat{BAC} = 90^\circ$  (the diagram is not drawn to scale). The point  $D$  is added to the side  $BC$  so that the line segments  $AD = BD$ . Show that the triangle  $ADC$  is also an isosceles triangle; fully explain your reasoning.



### Question 3

You are given that  $300 = 2^2 \times 3 \times 5^2$

a) Each factor of 300 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:  $10 = 2^1 \times 3^0 \times 5^1$   
 $12 = 2^2 \times 3^1 \times 5^0$

- What would  $a$  equal if you were writing an odd factor in this way?
  - How many values can  $c$  take?
  - Without making a list, how many factors does 300 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 2 which has 32 factors.

### Question 4

It takes 5 minutes to fill a bath using only the cold tap, and 7 minutes using just the hot tap.

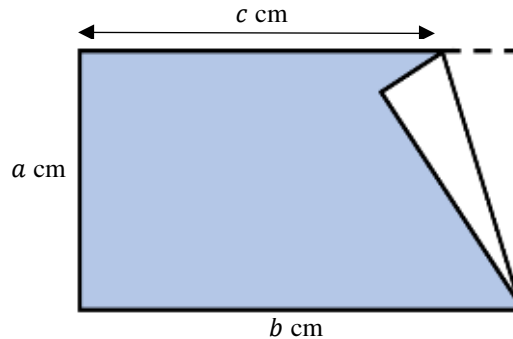
a) How long does it take to fill using both taps at once? Give your answer in minutes and seconds.

A full bath will empty in 3 minutes.

b) How long does it take to fill the bath using both taps at once, but with the plug removed? Give your answer in hours and minutes.

### Question 5

A rectangular piece of paper is blue on one side and white on the other. The paper is folded, with the fold starting in the bottom right-hand corner, as shown in the diagram. Show, algebraically, that the ratio  $c:b$  is the same as the ratio of the blue area which is still visible : the original area. [You can assume that the folded corner does not go beyond the edge of the paper]



### Question 6

At a fish farm, the owner wants to know how many fish there are in one pond. They catch 200 fish and tag each one before putting it back in. The next day they catch 150 fish, 12 of which are tagged. Estimate how many fish are in the pond.

### Question 7

A sequence has a first term equal to 6.

a) Write the next three terms of the sequence if the term-to-term rule is:

- i) add 7
- ii) multiply by 2

b) Instead, the term-to-term rule is “multiply by  $\frac{2}{3}$  then add 1”

- i) Write out the first 5 terms, leaving your answers as mixed numbers where appropriate
- ii) Expand and simplify  $\frac{2}{3}(3 + x) + 1$
- iii) Using part (ii), or otherwise, explain what happens to the terms in this sequence

### Question 8



A game uses the fair spinner above. There is one winning colour, but the game has a bonus round; if you land on a colour next to the winning one then you get to move the pointer one space in either direction.

- What is the probability of winning outright (on the first spin, without using the bonus round)?
- What is the probability of going to the bonus round?
- If you make it to the bonus round, what are your chances of winning?
- What is the overall probability of winning the game?

The maker of the game decides to change the number of sides so that the **overall** chance of winning is 10%.

- How many sides would the spinner need to have to make this happen?

**Question 9**

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

a) Find the solution to each of the following:

|   |   |   |
|---|---|---|
| (i)   | (ii)  | (iii)   |
| $\begin{array}{r} A \\ + A \\ \hline B A \end{array}$ | $\begin{array}{r} A B \\ + C B \\ \hline B B A \end{array}$ | $\begin{array}{r} A B C \\ + C B C \\ \hline C D E B \end{array}$ |

b) There are multiple solutions to the following

$$\begin{array}{r} O N E \\ + O N E \\ \hline T W O \end{array}$$

Find the only solution which **doesn't** contain the digits 1 or 2.

**Question 10** *In this question you are not expected to complete any large calculations*

A Mersenne Prime is a prime number which can be written as  $2^n - 1$  for some integer  $n$

a) One of the numbers below is a Mersenne Prime; deduce which one, giving a clear explanation of your reasoning:

524287,    524288,    524289

A narcissistic number is a number which is equal to the sum of its digits raised to the power of the number of digits.

For example  $153 = 1^3 + 5^3 + 3^3 = 1 + 125 + 27$   
 $1634 = 1^4 + 6^4 + 3^4 + 4^4 = 1 + 1296 + 81 + 256$

b)

i) Copy and complete the grids below by writing odd or even:

|      |          |     |      |      |     |     |      |
|------|----------|-----|------|------|-----|-----|------|
|      | $\times$ | Odd | Even |      | $+$ | Odd | Even |
| Odd  |          |     |      | Odd  |     |     |      |
| Even |          |     |      | Even |     |     |      |

ii) One of the numbers below is a narcissistic number; deduce which one, giving a clear explanation of your reasoning:

448834,    548834,    648834

**Question 11**

Using each of the digits from 1 to 9 exactly once, fill in a copy of this grid so that each row, column, and diagonal has the same sum.

|  |  |  |
|--|--|--|
|  |  |  |
|  |  |  |
|  |  |  |

**Q11 BONUS – no additional marks will be awarded, so make sure that you have thoroughly checked your answers to all the questions before attempting**

If you ignore reflections and rotations, then your solution to Q11 is unique. Explain why this is the case.

# Paper Notes: 13+ Maths Question Paper (13+ Maths Past Paper (2022))

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 **Academic Scholarship Mathematics Paper 2** from **Oundle School**, a 13+ entrance examination sat in 2022. The paper is designed for highly able candidates applying for academic scholarships and is deliberately challenging, testing mathematical insight, problem-solving creativity, and algebraic fluency well beyond standard Year 8 content.

The paper contains **11 questions** of varying difficulty, covering a broad range of topics including algebra, geometry, number theory, probability, and logical reasoning. Each question is worth different amounts, and candidates are explicitly told they are not expected to complete all questions. The emphasis is on method, explanation, and mathematical communication rather than speed.

This paper is ideal for students preparing for selective independent school entrance at 13+, particularly those aiming for scholarship level. **Calculators are not permitted**, so candidates must demonstrate strong numerical fluency and algebraic manipulation. The two-hour time limit requires strategic question selection and efficient working.

## How this paper is organised

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The paper consists of **11 main questions** plus one bonus extension task. Candidates have **2 hours** to complete the paper, with answers to be written on lined paper rather than on the question sheet itself. The rubric makes clear that students should choose questions they can answer best and are not penalised for incomplete attempts.

Questions vary significantly in structure. Some are multi-part (e.g. Question 3 has parts a, b, and c with multiple sub-questions), whilst others require a single extended proof or explanation (e.g. Question 2 asks for a geometric proof with full reasoning). Question 1 uses a table-completion format to explore algebraic simplification, whilst Question 11 is a classic magic square puzzle with an optional bonus extension on uniqueness.

No individual mark allocations are printed on the paper, reinforcing the expectation that candidates demonstrate thorough working and clear mathematical communication throughout. Answers should be given to **3 significant figures where necessary**, though many questions require exact answers in algebraic or fractional form.

## Topics covered

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- Algebraic simplification and manipulation: expanding, collecting like terms, and recognising how operations combine to eliminate the original variable (Question 1)
- Geometric proof using properties of isosceles triangles, angle relationships, and deductive reasoning (Question 2)
- Prime factorisation and systematic factor counting using index notation, including comparing factor counts of large numbers without listing (Question 3)
- Work rate problems: combining and subtracting rates, finding common denominators, and converting between time units (Question 4)
- Algebraic ratio and area relationships in folded geometry, requiring symbolic manipulation and proof (Question 5)
- Capture-recapture estimation methods in a real-world context (Question 6)
- Sequences defined by iterative rules, including mixed number arithmetic and analysis of long-term behaviour (Question 7)
- Multi-stage probability using tree diagrams and conditional probability, plus inverse problems involving spinner design (Question 8)
- Cryptarithmic puzzles: logic-based digit assignment with constraints (Question 9)
- Number theory including Mersenne primes, narcissistic numbers, and parity reasoning to eliminate possibilities without calculation (Question 10)
- Magic squares and mathematical reasoning about uniqueness under symmetry transformations (Question 11)

## How to use this paper for revision

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- Practise algebraic simplification by working backwards: take a simple final expression and create multi-step problems that lead to it, then verify your working forwards.
- For geometric proofs, always mark equal lengths and angles on diagrams using standard notation (tick marks for equal sides, arcs for equal angles) to keep track of given information.
- Learn the formula for counting factors from prime factorisation: if  $n = p_1^a \times p_2^b \times p_3^c$  then the number of factors is  $(a+1)(b+1)(c+1)$ .
- When tackling work rate problems, define one complete job as 1 unit and express each rate as a fraction per minute, then add or subtract these fractions.
- For cryptarithmic puzzles, start by identifying carry constraints: look at the leftmost column of the sum to determine which letter must equal 1.
- Strengthen probability skills by drawing tree diagrams for multi-stage events, labelling each branch with its probability and each outcome with the product of branch probabilities.
- Revise special number types (primes, squares, powers of 2) and learn to recognise them quickly:  $524288 = 2^{19}$  should be identifiable from its size and the fact it's even.

## Common mistakes to avoid

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- In Question 1, students often fail to simplify fully at each step, leading to unwieldy expressions that are hard to simplify at the end. Always collect like terms immediately.
- For geometric proofs like Question 2, many candidates assert rather than prove: saying 'ADC is isosceles' is not a proof. You must show  $AD = DC$  using angle properties and given information.
- In Question 3c, students frequently guess powers of 2 rather than using the factor-counting formula systematically. If  $2^n$  has 32 factors, then  $n+1 = 32$ , so  $n = 31$ .
- Question 4b catches many candidates: they forget the drain empties the bath, so the net filling rate is  $(\frac{1}{5} + \frac{1}{7} - \frac{1}{3})$  baths per minute, which is negative or very small. Check your rate makes sense.
- In cryptarithmic (Question 9), students often assign digits without checking all constraints. Always verify that your solution satisfies every column, including carries.
- For Question 10, many candidates attempt full calculations rather than using parity arguments. A six-digit even number cannot be narcissistic because  $4^6 + 4^6 + 8^6 + 8^6 + 3^6 + 4^6$  is odd (odd count of odd powers).

## Exam technique

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Begin by reading all questions carefully and identifying those that play to your strengths. The rubric explicitly states you need not complete every question, so prioritise quality over quantity. Aim to attempt five or six questions thoroughly rather than rushing through nine poorly.

Allocate roughly **10-12 minutes per question** on average, but be flexible: some multi-part questions (e.g. Question 3) may take 15 minutes, whilst others (Question 6) might take just 5. Always show full working, even for 'obvious' steps, as method marks are crucial at scholarship level. If stuck, move on and return later with fresh perspective.

For proof questions (2, 5, 10 bonus), write in complete sentences explaining each logical step. Use precise mathematical language: 'since triangle ABD is isosceles with  $AD = BD$ , the base angles ADB and BAD are equal' scores more highly than 'the angles are the same'. Time permitting, check numerical answers for reasonableness: if Question 4a gives a time longer than 7 minutes, something is wrong. Finally, tackle Question 11 only after you have polished your other answers, as the bonus carries no additional marks.

## What to revise alongside this paper

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To prepare effectively for scholarship-level 13+ mathematics, candidates should revise GCSE-level algebra including quadratic expansion, factorisation, and solving linear equations. Geometric proofs benefit from study of circle theorems, congruence, and similarity, even though these are formally taught later.

Number theory topics such as highest common factor, lowest common multiple, and systematic factor-finding are essential. Practise with Olympiad-style problems from UKMT Junior Mathematical Challenge past papers to develop the problem-solving creativity this paper demands. Questions 9, 10, and 11 are typical of recreational mathematics puzzles found in books by Martin Gardner or Simon Singh.

For progression, explore topics in elementary number theory (modular arithmetic, Fermat's Little Theorem) and combinatorics (permutations, combinations). The Isaac Mathematics platform and NRICH from Cambridge offer excellent enrichment problems that mirror the style and difficulty of scholarship papers.

## Key terms

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**Algebraic simplification, Isosceles triangle, Prime factorisation, Index notation, Work rate, Capture-recapture, Iterative sequence, Conditional probability, Cryptarithmic, Mersenne prime, Narcissistic number, Parity, Magic square, Geometric proof, Ratio**

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