13+ PAST PAPER PACK

# Eton College 13+ Maths 2022

## Complete Past Paper Pack

CONTENTS

# Eton College King's Scholarship Examination 2022

# MATHEMATICS A

**(One and a half hours)**

***Candidate Number:………………………………………………………***

***<u>Please write your candidate number on EVERY sheet</u>.***

***Please answer on the paper in the spaces provided.***

*This paper is divided into two sections:*
*Section I (Short-answer questions) – 50 marks available*
*Section II (Extended questions) – 50 marks available*

*Answer all of Section I and as many questions as you can from Section II.*

*The marks for each part of each question are given in square brackets.*

*Show all your working.*

*No diagram is drawn to scale.*

## *Neither calculators nor protractors may be used.*

***<u>ADDITIONAL MATERIALS</u>: NONE***

## Do not turn over until told to do so.

# Section I: Short-answer questions (50 marks)

1. Fully simplify the following expressions.
   a. $5y + 16 - 8y - 4$

[1]

   b. $\frac{3}{4}y - \frac{y}{2}$

[1]

   c. $\frac{y \times y \times y \times y \times y}{y^3}$

[1]

2. Find the value of the following, giving your answers as **reduced, mixed fractions.**

a. $115\frac{1}{3} + 62\frac{2}{5} - 71\frac{4}{9}$

[3]

b. $\left(\frac{81}{98} \div 3\frac{6}{7}\right) \times \frac{154}{9}$

[4]

c. $\left(3\frac{2}{3} - 2\right)^2$

[3]

3. Find the value of the following, giving your answers as **a decimal**.

   a. $0.018 \times 0.0045$

[3]

   b. $0.2 - (0.2)^3$

[4]

   c. $0.403 \div 0.062$

[3]

4.

| | | |
|---|---|---|
| 2 | 15 | 60 |
| 12 | 47 | 9 |
| 51 | 19 | 34 |

I choose a number at random from the grid shown above. I am equally likely to choose any of these numbers. Giving your answers as **fully simplified fractions,** find the probability that the number I choose is:

a. odd;

[1]

b. a multiple of 5;

[1]

c. a prime number;

[1]

d. not a multiple of 3.

[1]

5. If $p = 6$, $q = -2$ and $r = \frac{1}{2}$, find the value of the following expressions, **fully simplifying your answers.**

a. $p^2 - \frac{2q}{r}$

[3]

b. $\frac{p^3+q^3}{p+q}$

[3]

6. Solve the following simultaneous equations.

$$5x + 7y = 11$$
$$4x + 3y = 14$$

[4]

7. Solve the following equation for $x$. Give your answer as a **reduced, mixed fraction.**

$$\frac{2x+1}{4} + \frac{x-1}{10} = 2$$

[3]

8. There are 8 more boys than girls in a football squad of 32. What is the ratio of girls to boys in the squad in simplified form?

[3]

9. Annie is 44 years old and her father is 36 years older than her. How many years ago was Annie's father three times her age?

[3]

10. Megan, Flossy and Emma are sisters. Megan is 80% taller than Emma. Flossy is 25% taller than Emma. Find the percentage by which Megan is taller than Flossy.

[4]

# Section II: Extended questions (50 marks)

11.

a. I visit three stores with some pocket money. I spend one fifth of my pocket money in the first shop and one quarter of what remains in the second shop. What fraction of the original amount is left over to spend in the third shop?

[3]

b. I am choosing a new washing machine. The standard model costs £200 and uses $17\frac{1}{2}$ pence of electricity per hour in operation. The energy-saving model costs £550 but only uses $3\frac{1}{2}$ pence of electricity per hour in operation. I operate my washing machine for twenty hours a week, on average. If I buy the energy-saving model, after how many weeks would my reduced electricity costs balance out the additional purchase price?

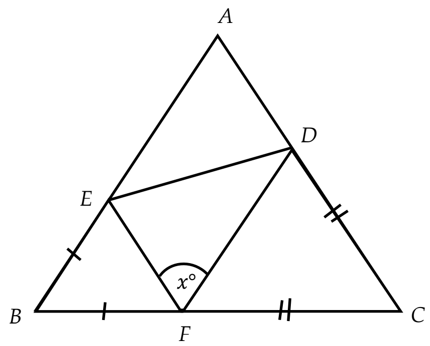
[3]

c. I run a cake stall on a Friday afternoon and spend 10 hours making 60 cakes. The ingredients for each cake costs me £1.60 and I charge £6 an hour for my labour. The sale price for a cake is 75% more than the total cost of making it. I have a special offer on this week which gives 20% discount on my normal sale price. How much will a customer pay for one of my cakes this week?

[4]

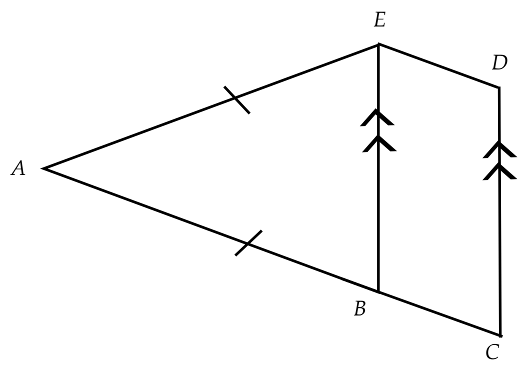
12.

a. A triangle $ABC$ is made up of four smaller triangles. $EBF$ and $DFC$ are isosceles triangles. Angle $EFD$ is $x°$ and is acute. Calculate the size of the angle $EAD$ in terms of $x$.




[3]

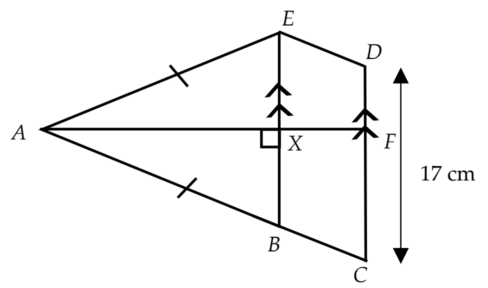
b. The shape below is formed by joining an isosceles triangle $ABE$ and a parallelogram $BCDE$. $ABC$ is a straight line and angle $BCD$ is $\left(\frac{90-5y}{4}\right)^{\circ}$.




i. Find angle $BAE$ in terms of $y$, **fully simplifying your answer.**

[3]

The line $AF$ intersects $BE$ at $X$ as shown in the diagram below. It is given that the length $DC = 17$ cm and the ratio of the length $AX$ and $XF$ is $3:2$.

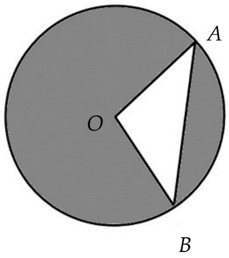



ii. Given that the area of $ABE$ is 78 cm$^2$, calculate the area of the parallelogram $BCDE$.

[4]

13.

a. A triangle $OAB$ is cut out of a circle with centre $O$. $OA$ and $OB$ are radii of length 35 cm and the chord $AB$ is of length 56 cm.




i. Find the area of the triangle $OAB$.

[2]

ii. Using $\frac{22}{7}$ as an approximation for $\pi$, calculate an estimate for the shaded area, **to the nearest 10 square centimetres.**

[2]

b. Pentagon $ABCDE$ is irregular but all five sides are each 34 cm long. Diagonal $AC$ is 66 cm and is parallel to side $ED$.

   i. Show that the area of triangle $ABC$ is $33\sqrt{x}$ cm$^2$, where $x$ is a positive whole number less than 100.

[2]

ii. Show, by calculating its value, that the area of quadrilateral $ACDE$ is a whole number of square centimetres.

[3]

iii. By making a suitable estimate for $\sqrt{x}$ in part i., find the area of pentagon $ABCDE$ **correct to the nearest 10 square centimetres.**

[1]

14.

a. If $m = \frac{7+n}{2}$ and $n = \frac{1+m}{2}$, find the value of $\frac{m+n}{2}$.

[2]

b. $x, y$ and $z$ are positive numbers.

$$x \times y = 6$$
$$y \times z = 27$$
$$z \times x = 2$$

i. Find the value of $(xyz)^2$.

[2]

ii. Hence find the values of $x, y$ and $z$.

[3]

c.

$$u + v = -3$$
$$v + w = -2$$
$$w + u = 6$$

Find the values of $u, v$ and $w$.

[3]

15.

a. X is a three-digit whole number. The sum of its digits is 12. If the second and third digits (that is, the “tens” digit and the “units” digit) are switched, the resulting number is 45 more than X.

Showing your method clearly, find all possible values for X.

*[Hint: let the letters a, b and c represent the three digits of X and start by finding two equations involving a, b and c].*

[4]

b. The numbers 1327231 and 394493 are both *palindromic*: they read the same when the order of their digits is reversed.

i. Find the largest five-digit palindromic whole number which is divisible by 3 but not divisible by 9.

[2]

ii. Of all possible five-digit palindromic whole numbers divisible by 15, Y is the largest and Z is the smallest. Find the difference between Y and Z.

[4]

**END OF PAPER**

# 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

This is the **Mathematics A paper** from **Eton College's King's Scholarship Examination 2022**, designed for candidates sitting the **13+ entrance exam** for Year 9 entry. It is a substantial test of mathematical fluency, problem-solving ability, and algebraic reasoning, requiring no calculator or protractor. The paper is structured to separate routine skills from more sophisticated mathematical thinking.

The exam is split into two sections: **Section I** comprises 10 short-answer questions totalling **50 marks**, covering core skills in algebra, arithmetic, probability, and percentages. **Section II** presents 5 extended questions, also worth **50 marks**, which demand multi-step reasoning, formal proofs, and clear exposition. The time allowance is **one and a half hours**, so pacing and efficiency are crucial.

This paper is ideal for students preparing for selective independent school 13+ entry exams, particularly those with a strong mathematical foundation looking to demonstrate depth of understanding. The absence of calculators tests mental arithmetic and estimation, while the mixture of routine and non-routine problems reflects the high standard expected for scholarships at institutions like Eton.

## How this paper is organised

The paper consists of **15 numbered questions**, divided into two distinct sections. Section I (questions 1 to 10) offers short-answer problems, each worth between 1 and 4 marks, and designed to be answered directly on the paper in the spaces provided. These questions are concise and test fluency in simplifying expressions, solving equations, calculating fractions and decimals, and applying probability and ratio concepts.

Section II (questions 11 to 15) contains extended problems, each with multiple parts and worth between 2 and 4 marks per part. These questions require sustained reasoning over several steps, with problems involving geometry, percentage calculations, algebraic manipulation, and number theory. Candidates are expected to show all working, and the questions build in complexity within each part.

The paper is clearly printed, with diagrams that are explicitly **not drawn to scale**, reminding candidates to rely on calculation rather than visual estimation. The rubric emphasises that candidates should attempt all of Section I and as many questions as possible from Section II, reflecting a design that challenges even the strongest mathematicians.

### Topics covered

- Simplification of algebraic expressions, including collecting like terms and applying index laws for powers of variables
- Arithmetic with mixed fractions and improper fractions, including addition, subtraction, multiplication, and division across common and uncommon denominators
- Decimal arithmetic: multiplication, subtraction, and division of decimals without a calculator, including interpretation of recurring patterns
- Probability calculations expressed as simplified fractions, covering single-event outcomes and interpretation of grid-based data
- Substitution of numerical values into algebraic expressions and simplification of results involving negative numbers and fractional powers
- Solving pairs of simultaneous linear equations using elimination or substitution methods
- Solving linear equations with fractional coefficients and expressing answers as reduced mixed fractions
- Ratio problems involving real-world contexts, including simplification and interpretation of part-to-part and part-to-whole relationships
- Age-related algebra problems requiring the formation and solving of linear equations with unknowns representing past or future ages
- Percentage increase and comparison problems, including multi-step percentage calculations and finding one quantity as a percentage of another
- Multi-step word problems combining fractions, percentages, and financial reasoning, including break-even analysis and cost modelling
- Angle reasoning in composite geometric figures, including isosceles triangles, parallelograms, and the use of algebraic expressions for angles
- Area calculations for triangles, parallelograms, circles, and irregular polygons, including the use of Pythagoras' theorem and Heron's formula
- Simultaneous equations with three unknowns, requiring systematic addition or elimination to solve for individual variables
- Algebraic number theory problems involving digit sums, palindromic numbers, and divisibility rules for 3, 9, and 15

## How to use this paper for revision

- Practise simplifying algebraic expressions systematically, paying close attention to index laws and the order of operations, particularly when negative signs or fractions are involved.
- Drill fraction arithmetic without a calculator until you can confidently add, subtract, multiply, and divide mixed numbers and improper fractions, converting between forms fluently.
- Strengthen mental arithmetic with decimals by working through multiplication and division problems step by step, writing intermediate results clearly to avoid careless errors.
- Review the key divisibility rules (especially for 3, 9, and 15) and practise applying them to multi-digit numbers, as they underpin several number theory questions.
- Work through angle problems in compound shapes by labelling all known angles, writing equations for unknowns, and checking that angles in triangles sum to 180° and that properties of isosceles triangles and parallelograms are applied correctly.
- Revise area formulae for standard shapes (triangles, parallelograms, circles) and practise applying Pythagoras' theorem and Heron's formula to irregular figures, showing all working step by step.
- When solving word problems, define your variables clearly at the start, write down the equations you derive from the problem statement, and check your final answer against the context to ensure it makes sense.

## Common mistakes to avoid

- Forgetting to simplify fractions fully, or leaving mixed numbers as improper fractions when the question explicitly asks for a reduced mixed fraction.
- Misapplying index laws, particularly when dividing powers: students often subtract exponents incorrectly or forget that $y^5 \div y^3 = y^2$ rather than $y^{15}$.
- Rushing decimal multiplication or division and losing track of place value, leading to answers that are out by a factor of 10 or 100.
- Confusing probability with ratio, or failing to simplify probability fractions, resulting in answers such as 4/9 being left as 8/18.
- Making sign errors when substituting negative values into algebraic expressions, especially when squaring or cubing negative numbers.
- In geometry problems, assuming diagrams are to scale despite the rubric warning, or failing to use algebraic reasoning when angles are given as expressions rather than numbers.

## Exam technique

Start with **Section I** and work through the short-answer questions methodically, aiming to complete them in approximately 40 minutes. These are designed to be direct and test core skills, so avoid spending too long on any single part. If a question is unclear, move on and return to it later rather than losing momentum.

For **Section II**, read each question carefully and identify what is being asked in each part before starting your working. Extended questions often build on earlier parts, so a mistake in part (i) can cascade unless you spot it early. Show all steps clearly, as partial credit is available even if your final answer is incorrect. Use the hint provided in question 15a to guide your approach, but do not rely on hints as a substitute for understanding the problem structure.

Manage your time by allocating roughly 50 minutes to Section II, and reserve the final few minutes to review your answers, particularly checking that fractions are fully simplified, that algebraic expressions are correct, and that numerical answers make sense in context. If a question asks for an answer to the nearest 10 square centimetres or as a reduced mixed fraction, ensure your final answer is in that form, as failing to follow instructions will cost marks even if your working is correct.

## What to revise alongside this paper

To prepare for this paper, ensure you are confident with **GCSE-level algebra**, including forming and solving equations, manipulating expressions, and working with indices and surds. Revise circle theorems, properties of quadrilaterals, and angle reasoning in composite figures, as these underpin the geometry questions in Section II.

Beyond the content of this paper, consider practising **proof and reasoning** questions that require you to show algebraic results or verify numerical properties, as these skills are assessed in questions 13b and 15. For students aiming for scholarship level, explore **Olympiad-style** problems involving number theory, combinatorics, and non-routine problem-solving to develop the flexibility and creativity required for the hardest parts of Section II.

Finally, strengthen your mental arithmetic and estimation skills by working without a calculator regularly, and practise working under timed conditions to build the speed and accuracy needed to complete both sections within 90 minutes.

## Key terms

> **Index laws**, **Mixed fraction**, **Improper fraction**, **Probability**, **Simplification**, **Simultaneous equations**, **Isosceles triangle**, **Parallelogram**, **Pythagoras' theorem**, **Heron's formula**, **Palindromic number**, **Divisibility rule**, **Percentage increase**, **Break-even analysis**, **Algebraic substitution**

---

# Eton College King’s Scholarship Examination 2022

# MATHEMATICS B

**(One and a half hours)**

***Candidate number:***.................................................

**<u>Please write your candidate number on EVERY sheet.</u>**

**Please answer on the paper in the spaces provided.**

There are 8 questions: each one is worth 10 marks.

Calculators are allowed, but you should show all your working.

## Do not turn over until told to do so.

1.

(a) Find the acute angle between the hour hand and the minute hand of a (standard) 12-hour analogue clock at 4:30pm.

(b) The point $Q$ lies on the side $AC$ of triangle $ABC$ such that $BQ$ and $CQ$ are equal in length and the angle $ABQ$ is half the angle $BQC$. Find the angle $ABC$.

(c) The point $R$ lies on the side $DF$ of triangle $DEF$ such that angle $REF$ is 20 degrees greater than angle $EFR$, angle $DER$ is a quarter of angle $FRE$, and angle $RDE$ is one third of angle $DRE$. Find the angle $RDE$ as a mixed fraction.

2.

(a) A cuboid has two faces each with area 504 square inches, two faces each with area 924 square inches, and two faces each with area 66 square inches. Find the volume of the cuboid, showing your reasoning clearly.

(b) A solid cuboid has four edges of length 10m, four edges of length 13m and four edges of length 15m. Vertices *A* and *B* are such that the diagonal *AB* is a space diagonal (that is, it passes through the interior of the cube). A thin piece of thread joins *A* and *B*, passing over the surface of exactly two of the faces of the cuboid and pulled tight to ensure that the thread is as short as can be. The length of thread between *A* and *B* is then measured.

Show that there are three possible lengths of thread, all lying between 27m and 30m, finding all three lengths to the nearest centimetre.

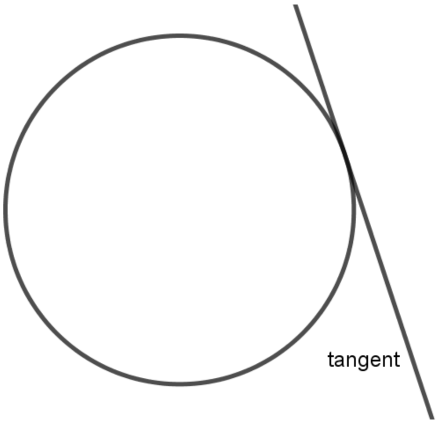
3.

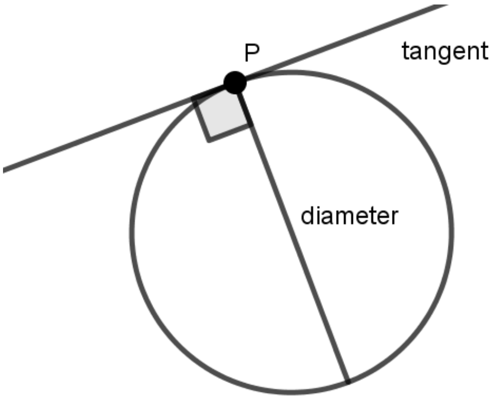
(a) Alice writes two lists of positive whole numbers. One contains all multiples of 144 less than 100,000,000. The other contains all multiples of 136 less than 100,000,000. How many numbers appear on exactly one of the lists?

(b) The Duchess is hosting a party and is sure that 760 people will attend. She knows that 532 of the guests like sandwiches, 608 like scones, 684 like cake and 722 like biscuits. Her cook is rather ill-tempered and so the Duchess is a little anxious about the catering. What is the smallest and the largest number of guests who could like all four foods?

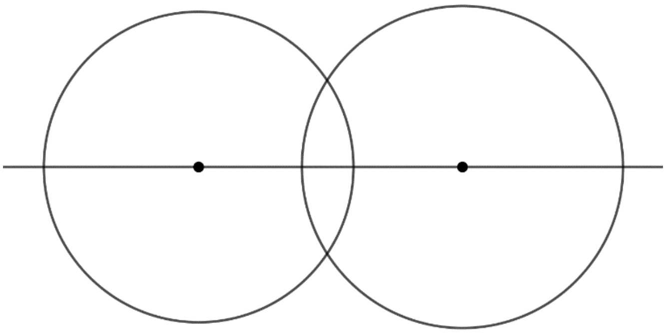
4. *The following facts about circles will be useful for this question:*

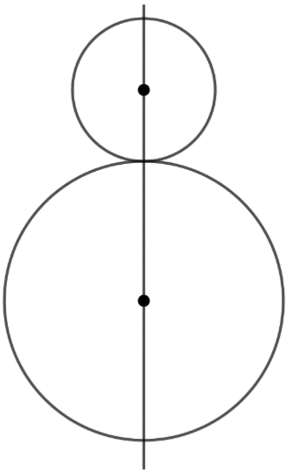
**Tangents and diameters**: A tangent to a circle is a straight line which touches the circle, at exactly one point, without crossing it. If a tangent touches a circle at the point *P*, the diameter to the circle from *P* is at 90 degrees to the tangent.



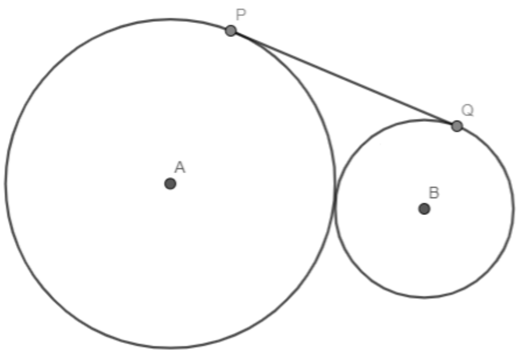




**Symmetry**: A straight line drawn through the centres of two circles is a line of symmetry for both circles.

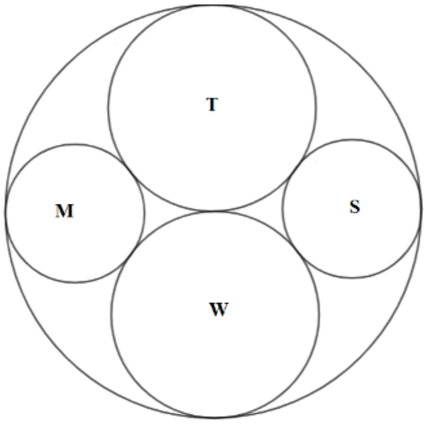




(a) The diagram shows two touching circles, one of diameter 72cm, centre *A* and one of diameter 50cm, centre *B*. The line segment *PQ* is a tangent to both circles. Find the length *PQ*.



(b) The Mad Hatter has a new tea set. The design is shown from above. The teapot (T) and water-jug (W) are the same size, as are the (smaller) milk-jug (M) and sugar-bowl (S); all these items are of circular cross section, as is the tea-tray on which they sit. The items fit snugly on the tray, i.e. the circles just touch each other and the sides of the tray.




The teapot is of diameter 30cm.

What is the diameter of the milk-jug?

4.(b) cont.

5.

The Queen of Hearts keeps three pet flamingos, one in the drawing room, one in the library and one in the hallway. The flamingos squawk at fixed time intervals: in the drawing room every $3\frac{1}{2}$ minutes, in the library every $3\frac{1}{4}$ minutes and in the hallway every $3\frac{1}{7}$ minutes.

All three squawk simultaneously at 12:00 noon on Monday, and next squawk simultaneously at time $T$.

(a) Find the time $T$, which is on the Tuesday, giving your answer using the 24-hour clock.

(b) Find on how many occasions between 12:00 noon on Monday and the time $T$ that the drawing room and hallway flamingos squawk simultaneously but not the library flamingo.

6.

(a) If $p$ caterpillars can eat $q$ mushrooms in $t$ minutes, how long will $r$ caterpillars take to eat $s$ mushrooms, eating at the same rate?

(b) The Queen's gardeners have three cylindrical water butts marked S, D and C respectively. They have different heights and different cross-sections. Each has a hole in its bottom; all the holes leak at exactly the same constant rate (i.e. the volume of water disgorged in a given time is the same for each). The butts are all full at noon. At 2pm, the depth of water in all the butts is the same. At 5pm, S runs dry. At 8pm, D runs dry. At 9:30pm, C runs dry. If D is 5cm taller than C, how tall is S?

6.(b) cont.

7.

(a) In the Queen's garden, there are $w$ white roses and $r$ red roses. Each white rose has $m$ petals and each red rose has $n$ petals. Half of the white roses lose two thirds of their petals and one third of the red roses lose one third of their petals. What is the new average number of petals per rose?

(b) The gardeners are diluting paint in order to paint the white roses red. They start with 10 litres of pure red paint in a paint kettle, but it is too thick, so they pour off a litre of paint into a bucket and pour a litre of water into the kettle before mixing thoroughly. The result is still too thick, so they pour off two litres of it and pour in two litres of water and then mix thoroughly. The result is still too thick, so they pour off three litres of it and pour in three litres of water and then mix thoroughly. Without checking the thickness of the resulting mixture, they pour off four litres of it and pour in four litres of water, only to discover on mixing that the final mixture is much too thin. They are resolved to do no more tampering, but they have kept the ten litres they have poured off in the bucket and discover to their relief that it is perfect for the job. What is perfect ratio of paint to water?

7.(b) cont.

8.

(a) Points $A$, $B$, $C$, $D$, $E$ and $F$ all lie on the same straight line, in that order. The length of various line segments are known in terms of values $x$ and $y$:

$AD = 6x + y$

$CF = 8x - 4y$

$AF = 9x$

$BD = 8y - 4x$

$CE = 2x + \text{y}$

Find the length of the line segment $BE$ in terms of $x$ and $y$.

(b) The duck, the eaglet and the lory are fond of racing. Each always maintains a constant speed: the duck is the fastest and the lory the slowest of the three. Because of this, the eaglet always starts the race some distance ahead of the duck but some distance behind the lory.

In one race, the eaglet overtakes the lory, and five minutes later, the duck overtakes the lory and then three minutes after that, the duck overtakes the eaglet.

In another race, the duck overtakes the lory nine minutes after overtaking the eaglet. After how many more minutes will the eaglet overtake the lory?

8.(b) cont.

[END OF PAPER]

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

Compiled by SATs-Papers.co.uk to help you get the most from this paper.

## Overview

This is the **2022 Eton College King's Scholarship Examination Mathematics B paper**, a 13+ entrance examination set by one of the country's most prestigious independent schools. The King's Scholarship is **Eton's most competitive academic award**, and this paper reflects the exceptional standard expected of candidates sitting for it. The examination lasts **one and a half hours** and comprises eight questions, each worth 10 marks, for a total of 80 marks.

The paper tests advanced problem-solving across a wide range of topics, including geometry, algebra, number theory, ratio, rates, and combinatorics. Questions are structured as multi-part problems that build in difficulty, often requiring candidates to integrate knowledge from different areas of mathematics. Calculators are allowed, but the emphasis is firmly on **clear reasoning and logical working**. The whimsical framing of several questions (referencing Alice in Wonderland characters such as the Duchess, the Mad Hatter, and the Queen of Hearts) adds a distinctive narrative flavour without diminishing the mathematical rigour.

This paper is aimed at **exceptionally able Year 8 students** preparing for competitive 13+ entrance examinations. It assumes mastery of the Key Stage 3 curriculum and extends well beyond it, demanding insight, persistence, and mathematical maturity. Candidates should be comfortable with abstract reasoning, multi-step problems, and presenting solutions in a structured, persuasive manner.

## How this paper is organised

The paper consists of **eight questions**, numbered 1 to 8, each carrying **10 marks**. Most questions are divided into two or three parts (labelled (a), (b), and occasionally (c)), allowing the examiners to assess a range of skills within a single thematic question. Each question occupies between one and four pages, with ample space provided beneath each part for candidates to write their solutions. The instructions specify that candidates should **answer on the paper in the spaces provided** and must write their candidate number on every sheet.

Time management is critical: with 90 minutes available for 80 marks, candidates have just over one minute per mark. However, the questions vary significantly in difficulty, and some parts (particularly those appearing later in a question or later in the paper) may require several minutes of concentrated thought. **Calculators are allowed**, but their utility is limited; the paper rewards mathematical insight over numerical computation.

The subject matter is diverse, spanning plane geometry, solid geometry, number properties, linear relationships, rates and proportions, and logical reasoning. The multi-part structure within each question often guides candidates through a line of reasoning, with earlier parts providing stepping stones to more challenging conclusions. The final question on each page is labelled with a continuation marker if it extends onto the next sheet, helping candidates keep track of their progress through the paper.

## Topics covered

- Angle relationships on analogue clocks, calculating angular displacement of hour and minute hands at a given time
- Triangle geometry with angle relationships, including isosceles triangles and angle bisectors, solving for unknown angles using deductive reasoning
- Systems of linear equations involving angles in triangles, working with fractional relationships between angles and applying angle sum properties
- Mensuration of cuboids, deducing dimensions from given face areas and calculating volume
- Shortest path problems on the surface of a cuboid (unfolding 3D shapes into nets), using Pythagoras' theorem to calculate geodesic distances
- Multiples and the inclusion-exclusion principle, working with large numbers and identifying elements appearing in exactly one of two sets
- Set theory and Venn diagram logic, determining minimum and maximum overlaps when given constraints on subset sizes
- Circle geometry: tangents, radii, and common tangents between two circles, using right-angled triangles and Pythagoras' theorem
- Packing problems involving circles of different radii within a larger circle, applying symmetry arguments and coordinate or distance geometry
- Least common multiples of mixed numbers (expressed as fractions), calculating time intervals for periodic events
- Algebraic manipulation of ratios and proportional relationships, expressing one variable in terms of others
- Rates and proportional reasoning with leaking cylinders of different dimensions, using volume and depth relationships
- Weighted averages involving algebraic expressions, calculating mean values after conditional changes to subsets
- Iterative dilution problems, tracking the concentration of a mixture through multiple stages of removal and replacement
- Algebraic manipulation on a number line, deducing unknown segment lengths from overlapping linear expressions
- Relative motion and overtaking problems with multiple participants at constant speeds, solving systems of rate equations

## How to use this paper for revision

- Practise unfolding cuboids into nets and identifying the shortest path between two vertices on the surface; sketch different unfoldings to see which yields the minimum distance.
- Revise the formula for the least common multiple of fractions: LCM(a/b, c/d) = LCM(a, c) / GCD(b, d); you will need this for periodicity problems involving mixed-number intervals.
- Strengthen your circle geometry knowledge, particularly the theorem that a tangent is perpendicular to the radius at the point of contact; many problems hinge on constructing right-angled triangles.
- Familiarise yourself with inclusion-exclusion logic and Venn diagrams for overlapping sets; be comfortable working out minimum and maximum overlaps from given totals.
- Work through multi-stage ratio and concentration problems methodically, tabulating the amount of each component at each step to avoid confusion.
- Review how to express the positions of hour and minute hands as functions of time, remembering that the hour hand moves continuously (not in discrete jumps) at 0.5° per minute.
- Practise forming and solving systems of linear equations from word problems, particularly those involving distances, rates, and times for overtaking scenarios.

## Common mistakes to avoid

- Forgetting that the hour hand moves continuously between hour markers, leading to an incorrect angle calculation at times like 4:30 (the hour hand is not at the 4; it is halfway between 4 and 5).
- In circle packing problems, assuming symmetry without justification or failing to draw a clear diagram showing radii and distances between centres; always sketch the configuration carefully.
- When unfolding a cuboid, not considering all possible pairs of adjacent faces; there are three distinct unfoldings corresponding to the three pairs of opposite edges of the space diagonal.
- In LCM problems with fractions, trying to find the LCM of the mixed numbers directly rather than converting to improper fractions and using the correct formula for fractional LCM.
- Misapplying inclusion-exclusion by subtracting the overlap only once when it has been counted multiple times, or vice versa; carefully count how many times each element appears in your sums.
- In iterative dilution problems, losing track of the total volume or the proportion of paint versus water after each stage; maintain a clear table or running calculation for each step.

## Exam technique

Begin by reading the entire paper quickly to identify questions that you find most accessible; these are your starting points. Allocate roughly 11 minutes per question, but be prepared to move on if you become stuck on a particular part. Many questions have multiple parts, and later parts may be independent of earlier ones, so do not abandon an entire question just because part (a) is difficult. **Show all working clearly**, even when using a calculator; examiners award marks for method as well as final answers, and partial credit can be earned even if your final answer is incorrect.

Time management is especially important in a paper of this difficulty. If a question requires an insight that is not immediately apparent, leave space and return to it after completing other questions. **Check your answers for reasonableness**: if you calculate an angle of 370° or a negative length, you have made an error. In geometry problems, accurate diagrams can reveal relationships that are not obvious from the problem statement alone, so invest time in drawing clear, labelled sketches.

In multi-stage problems (such as the dilution question or the racing problem), tabulate intermediate results to avoid losing track of your reasoning. For questions involving rates or proportions, identify the underlying relationship (e.g. volume per unit time, distance per unit time) and express it algebraically before substituting numbers. Finally, remember that **this is a scholarship paper**; examiners are looking for elegance and insight, not just correct answers. If you find a particularly neat solution, present it confidently.

## What to revise alongside this paper

Students preparing for this paper should ensure they have a solid grasp of **GCSE Higher Tier geometry**, including circle theorems, angle properties in polygons, and the use of Pythagoras' theorem and trigonometry in both 2D and 3D contexts. Algebraic fluency is essential: you should be comfortable manipulating linear expressions, forming and solving simultaneous equations, and working with fractions and ratio in both numerical and algebraic forms. Familiarity with **modular arithmetic and divisibility** will support the number theory questions, while a strong understanding of rates, proportions, and unit conversions underpins the problems involving leaking water butts and racing animals.

Beyond the core curriculum, explore **mathematical problem-solving resources** such as the United Kingdom Mathematics Trust (UKMT) Intermediate and Senior Mathematical Challenges, which share the paper's emphasis on insight and elegance over routine computation. Books such as "The Art of Problem Solving" series and "Mathematical Circles" will develop the kind of creative, non-standard thinking that Eton's King's Scholarship examiners value. Finally, practise presenting your reasoning clearly and logically; scholarship mathematics is as much about communication as it is about calculation.

For students aiming at other top independent schools' 13+ examinations (such as Winchester, Westminster, or St Paul's), this paper provides an excellent benchmark of the level of difficulty and breadth of knowledge expected. The whimsical problem settings (the Mad Hatter's tea set, the Queen's flamingos) are typical of Eton's house style, but the underlying mathematics is universal.

## Key terms

> **Acute angle**, **Isosceles triangle**, **Angle bisector**, **Cuboid**, **Face area**, **Volume**, **Space diagonal**, **Net (unfolding)**, **Pythagoras' theorem**, **Least common multiple (LCM)**, **Greatest common divisor (GCD)**, **Inclusion-exclusion principle**, **Tangent (to a circle)**, **Radius**, **Common tangent**, **Circle packing**, **Weighted average**, **Dilution and concentration**, **Proportional reasoning**, **Relative motion**, **Overtaking problems**, **Linear expressions**, **Systems of equations**

For more free 11+ practice papers, past papers and online practice tests, visit **SATs-Papers.co.uk**.