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Eton College 13+ Maths 2020

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CONTENTS

Eton College King's Scholarship Examination 2020

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.

If you run out of space, please use the Additional Working space on page 16.

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. Find the value of the following, giving your answers as reduced fractions (mixed, where appropriate):

a) $1\frac{5}{17} \times 1\frac{1}{33}$ [3]

b) $1\frac{2}{11} \div 4\frac{1}{3}$ [3]

c) $1001\frac{1}{5} - 999\frac{4}{5}$ [3]

[Total for Question: 9]

2. Find the value of the following, giving your answer as a decimal or whole number as appropriate:

a) 1.9×0.006 [3]

b) $0.0084 \div 0.0000028$ [3]

c) $(0.03)^4$ [3]

[Total for Question: 9]

3. Given that $304050 \times 55 = 16722750$, find the value of

a) $167227.5 \div 304.05$ [2]

b) $1.672275 \div 0.0055$ [2]

[Total for Question: 4]

4. Solve the following equation:

$$3(x-4) = 5(x-6) - 4(x-5)$$

[3]

[Total for Question: 3]

5. Solve the following inequality, leaving x on the left-hand side in your final answer:

$$-7x - 6 \geq 3(x + 2) - 4$$

[3]

[Total for Question: 3]

6. Solve the following pair of simultaneous equations:

$$5x = 7y + 27$$
$$7x = 5y + 57$$

[4]

[Total for Question: 4]

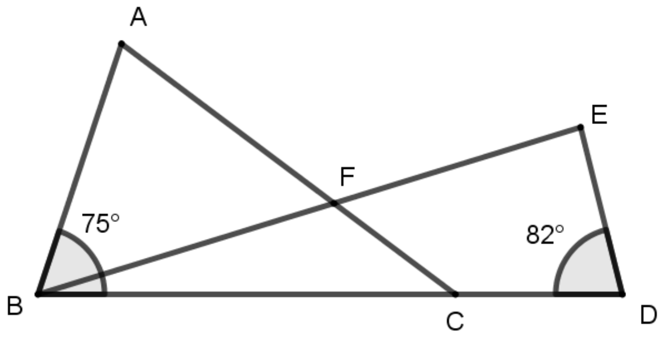
7. The mean of 3.2, 8.1 and x is one more than the mean of 3.9, 6.2, 6.9 and x.
Calculate x. [4]

[Total for Question: 4]

8. A survey asked respondents whether they subscribe to online streaming services *Webflix* and *Thames Prime*. $\frac{49}{120}$ of the respondents subscribe to neither service, and $\frac{11}{24}$ of the respondents subscribe to Thames Prime. If $\frac{4}{15}$ of the respondents subscribe to Webflix, what percentage of respondents subscribe to Thames Prime *only*? [5]

[Total for Question: 5]

9. In the following diagram, length AC = BC and length EB = DB. Angle EDB = 82° and angle ABC = 75°. Calculate angle AFE. [5]



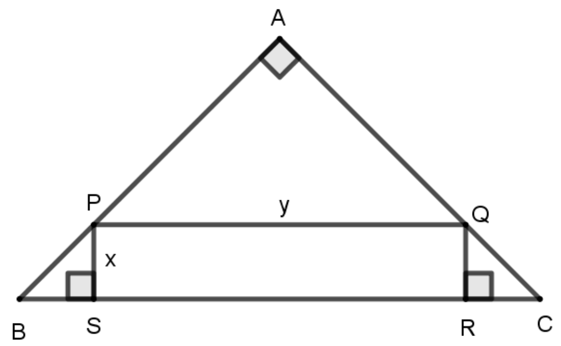
[Total for Question: 5]

10. In order to number the pages of a book, a printer uses a total of 1017 digits. How many numbered pages are there in the book? [4]

[Total for Question: 4]

Section II: Extended-answer questions (50 marks)

11. Right-angled triangle ABC is isosceles. PQRS is a rectangle. PS = x and PQ = y.



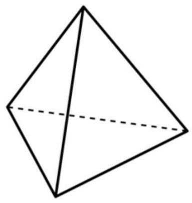
a) Find the area of triangle BPS in terms of x, justifying your answer. [2]

b) Find the area of triangle APQ in terms of y, justifying your answer. [4]

c) If triangle ABC has area 225 units^2, and if $y = 4x$, find x. [4]

[Total for Question: 10]

12. The diagram below shows a *tetrahedron*, which is a three-dimensional solid formed from four equilateral triangular faces:

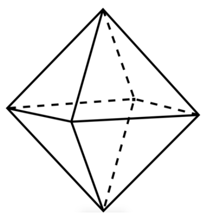


Each *face* is bounded by three *edges*, and three *edges* meet at a single point called a *vertex*.

a) How many edges does a tetrahedron have? [1]

b) How many vertices and edges does a cube have? [2]

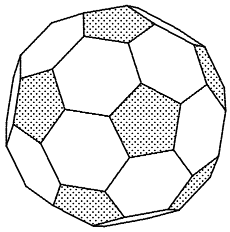
The diagram below shows an *octahedron*.



c) How many vertices and edges does an octahedron have? [2]

Question 12 continued

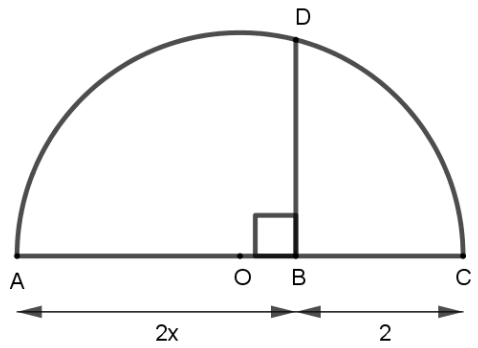
The diagram below shows a *truncated icosahedron*, which has 12 pentagonal faces and 20 hexagonal faces.



d) How many vertices and edges does a truncated icosahedron have? [5]

[Total for Question: 10]

13. The diagram shows a semicircle, centre O. AB = $2x$ and BC = 2. Angle ABD is a right angle.



a) Find a simplified expression, in terms of x, for the radius OD. [2]

b) Find a simplified expression, in terms of x, for the length OB. [2]

c) Using Pythagoras' Theorem, or otherwise, find and simplify an expression in terms of x for BD^2 (the square of length BD). [3]

d) If the circular arc ADC has length 122π, what is length BD? [3]

[Total for Question: 10]

14. Claire collects stamps. Her collection contains UK stamps and non-UK stamps. The ratio of UK to non-UK stamps in her collection is 6:11. Let m be the number of UK stamps in her collection and n be the number of non-UK stamps.

a) Find an expression for n in terms of m. [1]

If Claire were to swap her best 3 UK stamps for 14 additional non-UK stamps from another collector, the ratio of UK to non-UK stamps in her collection would become 3:7.

b) Form a second equation for n in terms of m. [4]

c) By solving the equations in a) and b) simultaneously, work out how many more non-UK than UK stamps Claire had in her original collection. [5]

[Total for Question: 10]

15. Alpha and Beta live at the opposite ends of the same street, 243 metres apart. One day, Alpha had to deliver a parcel to Beta's home, Beta one to Alpha's home. They started their journeys at the same moment, each walked at constant speed, and they returned home immediately after leaving the parcels at their respective destinations.

If Alpha walked at $1\frac{1}{5}$ m/s and Beta walked at $1\frac{1}{2}$ m/s:

a) how far from Alpha's home did they first meet? [3]

b) how many seconds after the time Alpha made the parcel delivery at Beta's home did the two meet again? [3]

Question 15 continued

Gamma and Delta also live at opposite ends of a different street and need to make reciprocal parcel deliveries in a similar way to Alpha and Beta. They started their journeys at the same moment and each walked at constant speed, but not necessarily the same speeds as Alpha and Beta. They first meet c metres from Gamma's home and they meet for a second time $(1000 - 2c)$ metres from Delta's home. *You may assume they meet for the second time after both have delivered their parcels.*

c) Find how long their street is, leaving your answer in terms of c. [4]

[Total for Question: 10]

END OF PAPER

ADDITIONAL WORKING

Paper Notes: 13+ Maths Question Paper (13+ Maths Past Paper (2020))

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

Overview

This is **Mathematics A**, a paper from the **Eton College King's Scholarship Examination 2020**. It forms part of the 13+ entrance assessment process for prospective King's Scholars at Eton and is designed to identify mathematically able candidates entering **Year 9**. The paper runs for **90 minutes** and awards a total of **100 marks**, split evenly between short-answer and extended problem-solving questions.

The paper tests a broad range of mathematical skills, from numerical fluency (fractions, decimals, powers) through algebraic manipulation and equation-solving to geometry, circle theorems, combinatorics, and word problems involving ratio, mean, and motion. Calculators are **not permitted**, so candidates must be confident working with exact values, simplifying surds, and reasoning with algebraic expressions. The questions increase in difficulty as the paper progresses, with Section II requiring clear justifications and multi-step reasoning.

This paper suits candidates aiming for academic excellence at **13+ level**, who have already covered the core KS3 curriculum and are comfortable with problem-solving under timed conditions. The mixture of routine technique and unfamiliar problem contexts (for example, Euler's polyhedron formula in disguise, and motion-on-a-line puzzles) makes it an excellent benchmark for mathematical maturity and creative thinking.

How this paper is organised

The paper is divided into two sections. **Section I** consists of ten short-answer questions worth a total of **50 marks**. Each question is subdivided into parts (typically three per question), and individual parts carry between 1 and 5 marks. Topics in Section I include fractions, decimals, equation-solving, inequalities, simultaneous equations, mean, set theory (Venn diagram logic), angle-chasing in triangles, and a digit-counting puzzle.

Section II offers five extended questions, also worth **50 marks** in total (10 marks per question). Each extended question is broken into sub-parts labelled (a), (b), (c), and sometimes (d), with individual parts carrying between 1 and 5 marks. Extended questions cover geometric reasoning (isosceles right-angled triangles with inscribed rectangles, semicircles with right-angled triangles), combinatorial counting on polyhedra (including Euler's formula applied to a truncated icosahedron), ratio and simultaneous equations involving a stamp collection, and motion problems on a line (meeting times and distances).

All answers must be written in the spaces provided on the paper. Candidates are instructed to show all working, and an additional working page is supplied at the end. The rubric states that diagrams are not drawn to scale and that neither calculators nor protractors may be used.

Topics covered

- Fraction arithmetic: multiplication and division of mixed numbers, simplification to lowest terms
- Decimal arithmetic: multiplication, division, and raising decimals to integer powers without a calculator
- Understanding place value and powers of ten to solve related calculations (e.g. scaling known products by factors of 10)
- Solving linear equations involving brackets and multiple terms on both sides
- Solving and expressing linear inequalities with algebraic manipulation
- Solving pairs of simultaneous linear equations by elimination or substitution
- Calculating mean (average) and setting up equations when means of different data sets are related
- Venn diagram logic with fractions: calculating overlaps between two sets and interpreting 'only' membership
- Angle properties in isosceles triangles and angle-chasing using base angles and exterior angles
- Problem-solving with digits: counting the total digits used to number pages in a book
- Area of triangles expressed algebraically; combining areas and solving quadratic relationships
- Combinatorial properties of polyhedra: counting vertices, edges, and faces (implicit use of Euler's formula $V - E + F = 2$)
- Circle geometry: radius, arc length, semicircles, and applying Pythagoras' theorem to right-angled triangles inscribed in circles
- Forming and solving simultaneous equations from ratios that change under specified conditions
- Motion problems: relative speed, meeting points, and interpreting journeys with turnarounds (two people walking towards each other and back)

How to use this paper for revision

- Practise fraction arithmetic without a calculator until you can multiply and divide mixed numbers confidently, reducing to simplest form in one go.
- Revise the rules for multiplying and dividing decimals: count decimal places carefully and remember that dividing by a small decimal yields a large quotient.
- For angle problems, mark all known angles on your diagram immediately and use isosceles triangle properties (base angles equal) to find unknowns systematically.
- When forming equations from ratio problems, define your variables clearly and write down what the ratio tells you (e.g. if the ratio is 6:11, then n = (11/6)m).
- In motion problems, draw a timeline or number line showing positions and times. Label the distance each person travels and use the fact that their combined distances equal the total distance.
- For polyhedra questions, count edges by summing (faces × edges per face) ÷ 2, since each edge is shared by two faces. Similarly, count vertices by summing (faces × vertices per face) ÷ (edges meeting at each vertex).
- Allocate your time: spend roughly 45 minutes on Section I (about 4 to 5 minutes per question) and 45 minutes on Section II (about 9 minutes per extended question). Leave time to check your work.

Common mistakes to avoid

- Forgetting to simplify fractions fully: always check whether numerator and denominator share a common factor, especially after adding or multiplying.
- Misplacing the decimal point when multiplying or dividing: write out your working in full rather than trying to do it in your head.
- Dropping negative signs when rearranging inequalities: remember that multiplying or dividing both sides by a negative number reverses the inequality sign.
- In simultaneous equations, failing to eliminate one variable cleanly: make sure coefficients match before subtracting, or you will introduce errors.
- In motion problems, assuming both people are always moving towards each other: read carefully to see whether anyone has turned around and is heading back.
- In extended geometry questions, not justifying your answer when asked: stating a formula or theorem (e.g. 'by Pythagoras') earns credit; just writing a number does not.

Exam technique

Tackle **Section I** first, as these questions test core technique and build confidence. Work through them in order, but if you get stuck on a particular part, move on and return to it later. Each part carries only a few marks, so spending five minutes on one fraction is poor strategy. Show all working clearly: even if your final answer is wrong, method marks may still be awarded.

In **Section II**, read each extended question in full before starting. Often part (a) sets up an expression that you will need in parts (b) or (c), so a mistake early on can cascade. If a question asks you to 'justify your answer', write a sentence explaining your reasoning or cite the theorem you used (e.g. 'Triangle BPS is right-angled, so area = ½ × base × height'). Marks are awarded for justification as well as the final expression.

Leave time at the end to check your work. Revisit any questions you skipped, and double-check arithmetic (especially decimal placement and sign errors). If you run out of space, use the additional working page at the back and indicate clearly where that working belongs. Since calculators are not allowed, neatness and clarity in algebraic manipulation are especially important: examiners cannot award marks for work they cannot follow.

What to revise alongside this paper

To prepare thoroughly for a paper at this level, revise **surds and irrational numbers** (simplifying √2, √3, etc.), as these often appear in geometry problems involving isosceles right-angled triangles and circles. Practise **forming and solving quadratic equations**, since part (c) of Question 11 leads to a quadratic relationship between x and y. Understanding **Euler's formula for polyhedra** (V − E + F = 2) will help you tackle Question 12(d) systematically, rather than trying to count edges by hand.

Beyond this paper, explore **coordinate geometry** (finding equations of lines, midpoints, and perpendicular bisectors), which is tested implicitly in motion problems and will feature heavily in GCSE and A-level mathematics. Work on **algebraic proof**: writing clear logical arguments to justify why a formula or relationship holds, not just checking it works for one example. This skill is central to the extended questions in Section II.

For candidates aiming at scholarship level, consider **Olympiad-style problem-solving** resources (UKMT Intermediate and Senior Mathematical Challenges, or books such as The Art and Craft of Problem Solving). These develop the creative thinking and multi-step reasoning that distinguish strong responses in Section II.

Key terms

> **Mixed number**, **Lowest terms (simplest form)**, **Linear equation**, **Inequality**, **Simultaneous equations**, **Mean (average)**, **Venn diagram**, **Isosceles triangle**, **Base angle**, **Right angle**, **Pythagoras' theorem**, **Radius**, **Arc length**, **Polyhedron (vertices, edges, faces)**, **Ratio**, **Relative speed**

Eton College King's Scholarship Examination 2020

MATHEMATICS B

(One and a half hours)

Candidate number: **…………………………………………………………………**

Please write your candidate number on EVERY sheet.

Please answer on the paper in the spaces provided.

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

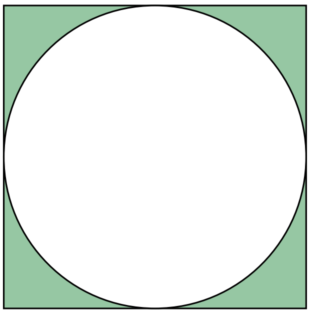
Calculators are allowed, but you should show all your working.

Do not turn over until told to do so.

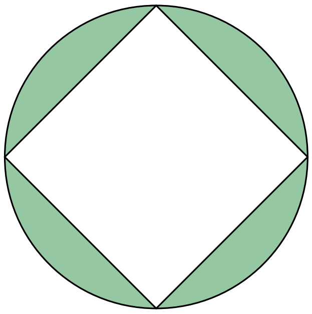
1. (a) The product of the length of the diagonals of a square is $450\,\text{cm}^2$.
Find the area of the square. [2]

(b) The pictures show a round plug in a square hole and a square plug in a round hole.

(i)



(ii)



In both pictures, the circle has radius r.

Find the ratio of the shaded area in (i) to the shaded area in (ii). Give your answer in the form $1 : x$, where x is a decimal to 3 significant figures. [4]

(c) Two circles of radius 10 cm and 24 cm have centres at A and C respectively. The circles intersect at the points B and D and the distance AC is 26 cm.

By considering the relationship between AB, BC and AC, find the area of the quadrilateral ABCD. [4]

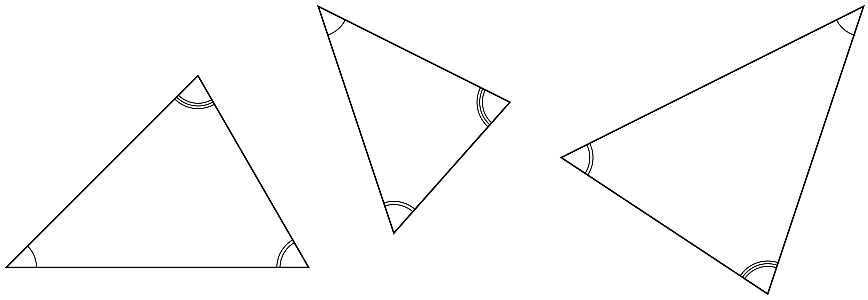
2. (a) To make ‘short’ pastry one uses flour to fat in the ratio 2 : 1. To make ‘flaky’ pastry requires a ratio of 4 : 3.

I have 29 kg of flour and 20 kg of fat and wish to use all the ingredients making some of each type of pastry. How much flaky pastry do I make? [5]

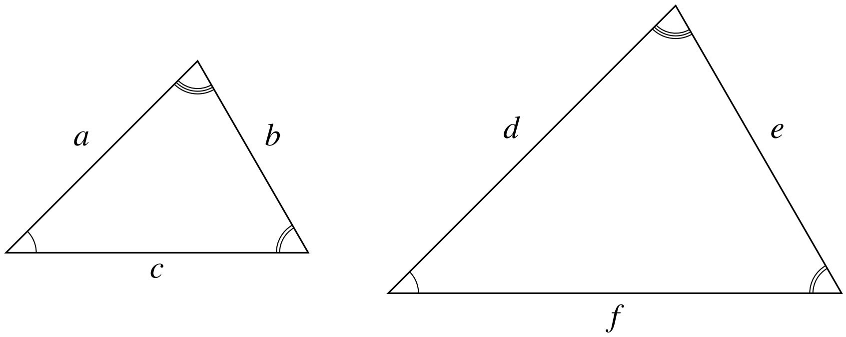
(b) By weight, raspberries are 85% water, raspberry jam is 30% water, and sugar contains no water. I make raspberry jam by mixing equal weights of raspberries and sugar and then boiling them to evaporate off some of the water.

What weight of jam can I make with 2.8 kg of raspberries? [5]

3. Two triangles are said to be *similar* if the angles in one are equal to the angles in the other. The three triangles below are all similar.

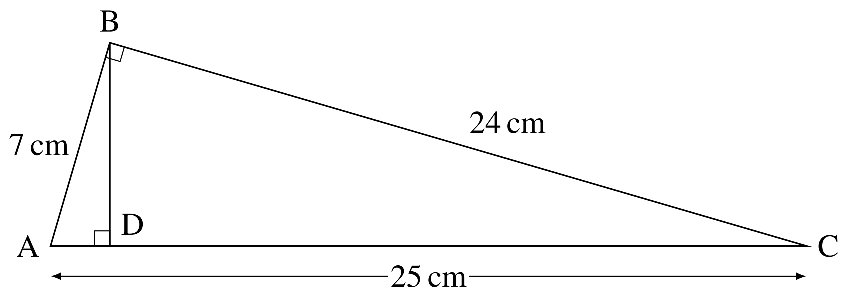


Similar triangles' sides are in the same ratios.



$$\frac{a}{d} = \frac{b}{e} = \frac{c}{f}$$

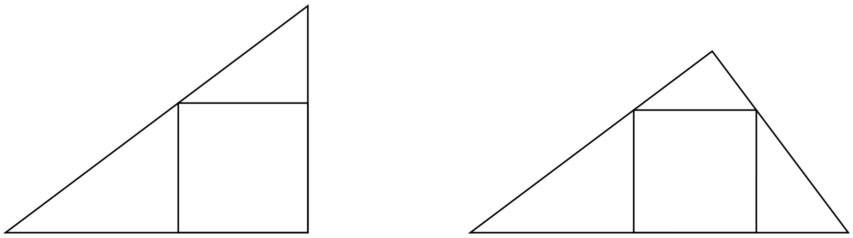
(a)



(i) By comparing angles show that $\triangle ABC$ and $\triangle ADB$ are similar. [2]

(ii) Using the similar triangles facts, find length BD. [2]

(b) There are two different inscribed squares that can be drawn in a triangle with side lengths of 3 cm, 4 cm and 5 cm.



Show that the ratio of the side lengths of the squares is 37 : 35 [6]

4. On the island of Etonia, I met three people A, B, and C, one of whom is a Teacher, one is an Oppidan, and the other is a Scholar. The Teacher always tells the truth, the Oppidan always lies, and the Scholar can either lie or tell the truth. (a), (b), (c) and (d) are separate questions.

   (a) A says, 'I am the Teacher.'

   B says, 'I am the Oppidan.'

   C says, 'I am the Scholar.'

   Who is the Scholar? Briefly explain your answer. [3]

   (b) Suppose instead that A says 'I am the Oppidan' and B says 'Yes, that's true, A is the Oppidan'. (C says nothing.)

   Who is the Teacher? Who is the Oppidan? Who is the Scholar? Briefly explain your answer. [2]

(c) Suppose instead that C says ‘B is the Teacher’ and B says ‘That’s wrong’. (A says nothing.)

Who is the Teacher? Who is the Oppidan? Who is the Scholar? Briefly explain your answer. [2]

(d) Suppose instead that A says ‘B is the Scholar’ and C says ‘A is the Oppidan’. Then B says ‘You have heard enough to determine who the Teacher is’.

Who is the Teacher? Who is the Oppidan? Who is the Scholar? Briefly explain your answer. [3]

5. (a) Solve for p, q and r. [3]

$$p + q = 13$$
$$q + r = 37$$
$$r + p = 15$$

(b) Solve for positive numbers, x, y and z. [3]

$$xy = 1125$$
$$yz = 864$$
$$xz = 750$$

(c) Solve for positive numbers a, b and c. [4]

$$a(b+c) = 120$$
$$b(c+a) = 144$$
$$c(a+b) = 168$$

6. (a) A man and a son are comparing their ages. The father says ‘Your age now is the same as my age written backwards’. The son says ‘Last year you were twice as old as I was then’. How old are they now? [3]

(b) I have 20 iron bars. Some are 3 kg, some are 8 kg and the rest are 14 kg. The total mass of all twenty is 183 kg.

Determine the number of each bar. [7]

7. The mean of two positive numbers, a and b, is $\dfrac{a+b}{2}$

This is properly called the *arithmetic mean* (AM) and is actually just one of many different types of means. Two others are:

Geometric mean (GM): $\sqrt{ab}$

Harmonic mean (HM): $\dfrac{2ab}{a+b}$

(a) Show that in each case $a <$ HM $<$ GM $<$ AM $< b$

(i) $a = 4$, $b = 9$ [1]

(ii) $a = 50$, $b = 800$ [1]

(b) (i) Explain why, for any numbers a and b, $(a-b)^2 \geqslant 0$ [1]

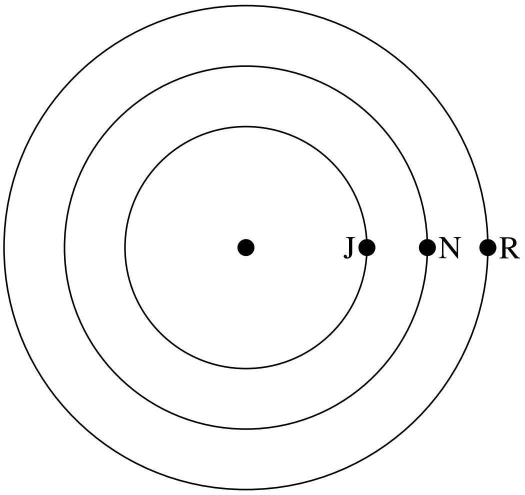
(ii) Hence show that $2ab \leqslant a^2 + b^2$ [2]

(c) Hence show that for positive numbers x and y, $\sqrt{xy} \leqslant \dfrac{x+y}{2}$ [2]

(d) Show further that, for positive x and y, $\dfrac{2xy}{x+y} \leqslant \sqrt{xy}$ [2]

(e) Under what circumstances is AM = GM = HM? [1]

8. Joel, Nick and Robin all run laps of a circular track at constant speeds. Joel has the inside lane and takes 1.25 minutes to finish a lap, Nick takes 3 minutes to finish a lap and Robin takes 10 minutes to finish a lap. They all start lined up across the track, as shown, and run anticlockwise.



(a) Show that it takes half an hour until all three runners are **next** at the starting point together. [2]

(b) Show that there is an earlier time when all three runners are first on a straight line through the centre with at least one at the starting point and at least one on the opposite side. State how many laps each runner will have run at this time. [2]

(c) Find the first time after the start that all three runners form a straight line with the centre of the track (not necessarily in their original positions nor on the same side of the centre as each other). Give the time in minutes and seconds, to the nearest second. [6]

END OF PAPER

Paper Notes: 13+ Maths Question Paper (13+ Maths Past Paper (2020))

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

Overview

This is the **Mathematics B** paper from **Eton College's King's Scholarship Examination 2020**, designed for students sitting the **13+ entrance exam** for Year 9 entry. The paper tests advanced mathematical problem-solving across geometry, ratio and proportion, algebra, logic puzzles, and systems of equations, all under timed conditions with calculators permitted.

The exam consists of **eight questions, each worth 10 marks**, to be completed in **one and a half hours**. Questions range from straightforward geometric calculations (areas, circle-square relationships) through applied problems involving pastry recipes, jam-making percentages, and age puzzles, to sophisticated proofs about arithmetic, geometric, and harmonic means. The logic section features truth-teller and liar problems set on the fictional island of Etonia.

This paper suits highly able Year 8 students preparing for scholarship or top-tier independent school entrance exams. It assumes fluent command of GCSE-level algebra and geometry and rewards inventive thinking, algebraic manipulation, and the ability to construct clear written arguments. The variety of contexts (from inscribed squares to runners on a circular track) tests mathematical modelling as much as procedural skill.

How this paper is organised

The paper comprises **eight questions numbered 1 to 8**, each allocated exactly **10 marks**. Most questions are divided into labelled sub-parts (a), (b), (c), with individual mark weightings shown in square brackets. The total available is **80 marks**, and students have **90 minutes** to complete their work.

Question 1 explores area and shaded-region problems involving squares and circles. Question 2 addresses ratio and percentage problems in practical contexts (pastry-making and jam production). Question 3 introduces similar triangles and inscribed squares. Question 4 presents four logic scenarios on the island of Etonia, each requiring deductive reasoning about truth-tellers, liars, and a Scholar who may do either. Question 5 moves through progressively harder systems of equations, from simple linear addition to non-linear products and more complex forms.

Questions 6, 7, and 8 form the most demanding final third. Question 6 combines age puzzles with three-variable integer problems. Question 7 systematically builds a proof of the AM-GM-HM inequality through five sub-parts, requiring both numerical verification and algebraic demonstration. Question 8 tackles a runners-on-a-track problem involving least common multiples and angular reasoning. The layout assumes answers will be written directly onto the question paper in the spaces provided.

Topics covered

- Area of squares and circles; diagonal properties of squares; calculating shaded regions formed by overlapping geometric shapes
- Ratio and proportion in multi-ingredient problems; using simultaneous equations to allocate resources between two mixtures with different ratio requirements
- Percentage composition by weight; calculating mixture outcomes after evaporating water from fruit and sugar blends
- Properties of similar triangles; identifying angle equalities; using side-length ratios to find unknown lengths in right-angled and compound triangles
- Inscribed squares within right-angled triangles; applying similar triangle principles to find and compare the side lengths of different inscriptions
- Logic puzzles involving consistent truth-tellers, consistent liars, and unpredictable Scholars; deducing identities from statements and meta-statements
- Solving systems of linear equations in three variables; solving systems of product equations (xy, yz, xz) by multiplicative techniques; solving non-linear systems involving products of sums
- Age problems with digit reversal and temporal conditions; three-variable integer problems constrained by total count and total mass
- Arithmetic mean, geometric mean, and harmonic mean; numerical verification of the AM-GM-HM inequality; algebraic proof starting from $(a - b)^2 \geq 0$
- Least common multiples and cyclic motion; finding when three runners with different lap times align on a circular track; angular reasoning and fractional laps

How to use this paper for revision

- Practise manipulating systems of equations both by substitution and by adding or multiplying equations together; the product systems in Question 5(b) reward spotting that xyz appears in multiple products.
- For logic puzzles like Question 4, sketch a truth table or case-by-case analysis; identify who cannot be the liar first, then deduce the others.
- Revise Pythagoras thoroughly, especially recognition of Pythagorean triples (3-4-5, 5-12-13, 7-24-25); many parts of Questions 1 and 3 hinge on quick identification of right angles.
- In ratio and percentage problems (Questions 2a and 2b), set up clear equations for each ingredient and solve simultaneously; check your totals add up at the end.
- When proving inequalities (Question 7), start from a known fact like $(a - b)^2 \geq 0$ and expand or rearrange systematically; each step must follow logically from the last.
- For Question 8, convert lap times into fractions of a full rotation per minute, then find when those fractions align; least common multiples are central to cyclic problems.
- Always show full working even if calculators are allowed; partial marks are awarded for method, and examiners need to see your reasoning in proof questions.

Common mistakes to avoid

- In Question 1(b), students often calculate only the area of the square or the circle and forget to subtract to find the shaded region, or they mix up which is (i) and which is (ii).
- Question 2(a) trips up candidates who set up two separate equations but forget they must use all 29 kg of flour and all 20 kg of fat simultaneously; solving for only one variable leaves the problem incomplete.
- In Question 4, assuming the Scholar always lies (or always tells the truth) is a frequent error; the Scholar can do either, so you must test both possibilities in your case analysis.
- Students attempting Question 5(c) often expand the brackets prematurely and lose track of variables; factoring or looking for symmetry first saves algebraic mistakes.
- For Question 7(c), many learners forget that $\sqrt{xy}$ and $(x + y)/2$ are both positive, so squaring both sides is valid; failing to square leads to an incomplete proof.
- In Question 8(c), candidates sometimes list only whole-lap alignments and miss fractional positions; the runners can form a straight line without any being exactly at the start or halfway point.

Exam technique

Begin by skimming all eight questions and identifying your strongest topics; tackle those first to bank marks confidently. Question 1(a) and Question 5(a) are relatively short and can be completed quickly, giving you early momentum. Leave Question 7 (the means proof) and Question 8(c) (the runners problem) until you have secured marks elsewhere, as they require sustained reasoning and are harder to finish under time pressure.

Allocate roughly **10 to 11 minutes per question** on average, but be flexible; simpler parts like 1(a) may take three minutes, while 7(b)(ii) and 8(c) may need fifteen. Use the mark allocation in brackets as a guide: a [2] part should not consume ten minutes of your time. If you are stuck on a proof or a logic puzzle, write down your partial reasoning (case analysis, trial substitutions) and move on; partial marks are better than none.

Show every step of your working clearly, even for calculator-permitted questions. In proof questions (3(a)(i), 7(b)(ii), 7(c), 7(d)), examiners award marks for logical progression, so write "Since $(a - b)^2 \geq 0$, expanding gives..." rather than jumping to the conclusion. For multi-part questions, read all sub-parts before starting; sometimes part (c) depends on a result from part (b), so if you cannot finish (b), at least state the result you would use. Finally, check units and significant figures (Question 1(b) asks for three significant figures); small slips in final answers cost marks even if your method is sound.

What to revise alongside this paper

Students should consolidate their understanding of **circle theorems** (tangents, chords, angles subtended by arcs) and **properties of quadrilaterals** (kites, rhombuses, cyclic quadrilaterals), as these underpin the geometry in Questions 1 and 3. Revise **algebraic proof techniques**, particularly rearranging inequalities and working from standard results like the difference of squares or the expansion of $(a + b)^2$; these are essential for Question 7.

For the logic puzzles in Question 4, practise **propositional logic and truth tables** from discrete mathematics or computing; this formalises the case-by-case reasoning needed. Strengthen your command of **non-linear simultaneous equations** (solving for variables in products or quotients) by working through additional problems from GCSE Higher or IGCSE Extended syllabuses. Finally, explore **modular arithmetic and cyclic patterns** for Question 8, as these concepts recur in number theory and can simplify least common multiple calculations.

To progress beyond this paper, attempt **UKMT Senior Mathematical Challenge** problems, **BMO1 (British Mathematical Olympiad Round 1)** past papers, or **STEP I foundation questions** for further proof and problem-solving practice. These resources develop the inventive thinking and algebraic fluency that scholarship mathematics at this level demands.

Key terms

> **Diagonal**, **Shaded area**, **Ratio and proportion**, **Percentage composition**, **Similar triangles**, **Inscribed square**, **Pythagorean triple**, **Truth-teller and liar logic**, **System of equations**, **Simultaneous equations**, **Product of sums**, **Arithmetic mean (AM)**, **Geometric mean (GM)**, **Harmonic mean (HM)**, **Inequality proof**, **Least common multiple (LCM)**, **Cyclic motion**, **Angular displacement**
