Secondary Mathematical Challenges

Welcome to the 2024-2025 Scottish Secondary Mathematical Challenges. This package contains

This Welcome Page (including Section Information)
The Secondary Guidelines
Round 1 Questions
Information About Payments
Data Protection and Privacy Policy
How to Enter your School and Pupil Names on the Marks Website
The Annual Poster
Archives and Book Order Form

Once again, the name of the Section Organiser is not on the question paper. Their details are on the website but are repeated here for convenience:

Section 1

Aberdeen City; Aberdeenshire; Highland; Moray; Orkney Islands; Shetland Islands; Western Isles

Dr Richard Hepworth (r.hepworth@abdn.ac.uk)
Mathematical Challenge
Department of Mathematical Sciences, University of Aberdeen,
Aberdeen AB24 3UE

Section 2

Angus; Clackmannanshire; Dundee City; Falkirk; Fife; Perth & Kinross; Stirling

Dr Jean Reinaud (jnr1@st-andrews.ac.uk)
Mathematical Institute, University of St Andrews,
St Andrews, Fife KY16 9SS

Section 3

East Lothian; Edinburgh City; Midlothian; Scottish Borders; West Lothian

Andrew Gallacher (A.Gallacher@napier.ac.uk)
Head of Teacher Education, Edinburgh Napier University, School of Applied Sciences,
Room 2.B.37, Sighthill Court, Edinburgh EH11 4BN

Section 4

Argyll & Bute; Dumfries & Galloway; East Ayrshire; East Dunbartonshire;
East Renfrewshire; Glasgow City; Inverclyde; North Ayrshire; North Lanarkshire;
Renfrewshire; South Ayrshire; South Lanarkshire; West Dunbartonshire

Scottish Mathematical Challenge Organiser (wpr3145@gmail.com),
Department of Mathematics and Statistics, University of Strathclyde,
26 Richmond Street, Glasgow G1 1XH

The competition timetable for 2024-2025 is as follows:

Set No.	*Last date for receipt of questions by schools*	*Last date for receipt of solutions from pupils*
I	Friday 23 August 2024	Friday 1 November 2024
II	Friday 22 November 2024	Friday 21 February 2025

If there are organisational difficulties you may contact me, Bill Richardson, (wpr3145@gmail.com).

The Scottish Mathematical Council

MC homepage: www.scot-maths.co.uk/

MATHEMATICAL CHALLENGE 2024−2025

A national problem solving competition for schools in Scotland

S E C O N D A R Y D I V I S I O N S

GUIDELINES FOR TEACHERS

1. ***Mathematical Challenge*** is a problem-solving competition which goes back to 1976. The Challenge is open to all students educated in Scotland. Its aim is to promote mathematics as a source of interest and pleasurable achievement through challenging problems which require only elementary techniques and simple logic.

   Please ensure that all teachers involved in the competition see these Guidelines.

How Mathematical Challenge operates

2. There are four divisions: JUNIOR for Sl and S2, MIDDLE for S3 and S4, SENIOR for S5 and S6, and PRIMARY (for which a separate circular is available).

   Pupils may enter only one division and must specify that division on their first entry.

   Please contact your local organiser, whose name and address are on the proforma on page 2 of each problem sheet and in the Contacts section of the Web pages, if there is any doubt about divisions, or if further information is required.

3. There are no written examinations. For the Junior, Middle and Senior Divisions, two sets of five problems each will be available for schools to download according to a timetable outlined in §13 below. Problems for different divisions will be on separate sheets. Some problems may be common to different divisions. The problems will also be available from the Mathematical Challenge Web pages (see above for address).

4. **A registration fee is required from participating schools. For a secondary school the fee is £20 for the first 10 entrants and £15 for each subsequent batch of 10 entrants or part thereof. A fee form is included with the downloadable pack of materials.**
   For individual participants NOT entering through a school, the fee is £8.

Entries and Marking

5. **Entries must be the unaided efforts of individual pupils. Group working is not appropriate in Mathematical Challenge.** Participants may consult books or the internet for information on facts or on how to tackle problems. Whilst teachers or parents may give guidance on interpretation of wording, **they should not be involved in the solution of a problem.** Furthermore, **the work should not interfere with normal teaching and in no circumstances should it be a class assignment.**

6. All Sections must use the software package to assist in the processing of the results. A **Record of Entries must be made electronically by the school**, or it will not be possible to process the results.

   - Go to the marks website: https://www.scottishmathschallenge.org.uk/
   - Choose "School Login" and enter your login details or "Register here" to set up a new account.
   - When you have logged in, go to "Add/Edit Entrants" _ enter the names and school year of each entrant.
   - The marks will eventually appear on the "Marks page".
   - Messages from the organiser may also appear there on the first page from time to time.

   Use a paper copy of the 'Printable version of details and entrants' from the marks website as a cover sheet for the school's entries. This contains the school details and the alphabetical list of entrants in each section, as entered on the website. All entries submitted will be marked even if earlier problem sets are missed.

7. Entries will not be returned. Entrants should keep a copy of their solutions. The Scottish Mathematical Council reserves the right to publish good solutions in its Journal.

8. **Participants should explain their solutions as fully as they can**. Marks will be given for explanations of answers not just for the answers themselves. **We should be most grateful if teachers would stress this point**. Incomplete or incorrect answers may gain some credit.

   In outline, the marking scheme for each problem is as follows:

   4 : a completely correct solution, with full explanation.

   3 : a solution, with explanation, which is correct apart from a minor slip or omission of a special case.

   2 : a solution with explanation which contains a serious error or omission, but which nevertheless involves good ideas.

   1 : there is an indication of an interesting idea or method, but not necessarily one which could lead to a correct solution.

   A *bonus* mark may be given for a completely correct solution, with full explanation, which contains additional good ideas, such as a successful generalisation of the problem.

   A solution in which an answer is given without any explanation will normally be awarded no marks, even if the answer is correct. However, correct working may be accepted as providing an explanation, so long as the various steps are clear.

9. No problems set in ***Mathematical Challenge*** require the use of a computer package (e.g. a spreadsheet) to obtain a correct solution. If computer software is used, then a proper mathematical explanation of its use is essential.

Awards

10. There are three classes of award: ***Gold***, ***Silver*** and ***Bronze***. Award winners will be selected primarily on the basis of the total number of marks obtained over both sets of Problems. Special circumstances for individual entrants may be taken into account.

11. All award winners will qualify for certificates. Where an award ceremony can be arranged, the most successful entrants will be invited to attend to receive their certificates and Mathematical Challenge mugs. Certificates not presented at a ceremony will be sent by post.

Important notes

12. Large numbers of entries can impose a considerable strain on markers and on organisers. Local organisers may have to set limits on the total numbers of entries per school. Schools submitting large numbers of entries may be asked to provide additional markers. Any such markers would not mark entries from their own schools.

13. The timetable for 2024-2025 is as follows:

Set No.	***Last date for receipt of questions by schools***	***Last date for receipt of solutions from pupils***
I	Friday 23 August 2024	Friday 1 November 2024
II	Friday 22 November 2024	Friday 21 February 2025

14. **The problems of earlier sessions form an excellent resource.** Those for the years 1991-92 to 2005-2006, including solutions, are available in the books *Mathematical Challenges III*, *Mathematical Challenges IV*, *Mathematical Challenges V* and *Mathematical Challenges VI* which are published by The Scottish Mathematical Council. Copies can be obtained from Bill Richardson, Kintail, Longmorn, Elgin IV30 8RJ, prices £7.50, £8, £8, £8 respectively.

    In addition, it seems unlikely that any further books will be printed so questions and solutions for 2006-2021 can be accessed at: **www.wpr3.co.uk/MC-archive/**

    Comments on the usefulness of these to wpr3145@gmail.com would be welcome.

15. For other information, please contact your local organiser, whose name and address are given in the Contacts section of the Mathematical Challenge Web pages

    www.scot-maths.co.uk

    as well as on the materials download menu page

    www.wpr3.co.uk/MC/materials

The Scottish Mathematical Council

www.scot-maths.co.uk

MATHEMATICAL CHALLENGE 2024−2025

Entries must be the unaided efforts of individual pupils.
Solutions must include explanations and answers without explanation will be given no credit.
Do not feel that you must hand in answers to all the questions.

CURRENT AND RECENT SPONSORS OF MATHEMATICAL CHALLENGE ARE
The Edinburgh Mathematical Society, The Maxwell Foundation,
The London Mathematical Society and The Scottish International Education Trust.

The Scottish Mathematical Council is indebted to the above for their generous support and gratefully acknowledges financial and other assistance from schools, universities and education authorities.

Particular thanks are due to the Universities of Aberdeen, Edinburgh Napier, Moray House, St Andrews, Stirling, Strathclyde and to George Heriot's School, Gryffe High School and Kelvinside Academy.

Junior Division: Problems 1

J1. Over coffee the other day my friend MacAngus and I were mulling over the passing of time. 'Four years ago', MacAngus said, 'I was four times as old as young Callum and now I'm only three times as old.'

'If you go on like that' I said, 'you'll soon both be the same age.'

When we finished laughing over this fallacy, it occurred to me that from what MacAngus said it would be possible to figure out his age. How old is my friend MacAngus?

J2. Four explorers wish to get one of their number as far as possible into the wilderness from their base. Each explorer can carry supplies for up to 10 days. At any time supplies can be transferred between explorers and individual explorers can return to base, provided they have sufficient supplies for the return journey. Supplies cannot be left unattended in the wilderness.

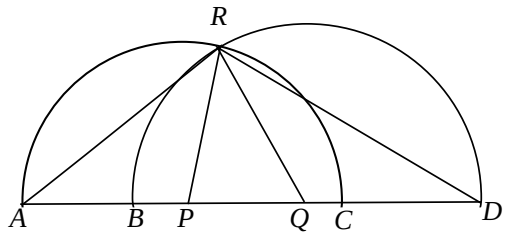
What is the greatest number of days the lead explorer can travel from the base so that all return safely?

J3. An integer n, between 100 and 999 inclusive, is chosen at random. What is the probability that the sum of the digits of n is 23?

J4. A van delivering maths textbooks travels to a school at an average speed of 60mph. Due to a mechanical problem the van could only do the return journey at an average speed of 40mph.

What was the van's average speed over the entire journey?

J5.



In the diagram, points B, P, Q and C lie on line segment AD. The semi-circle with diameter AC has centre P and the semi-circle with diameter BD has centre Q. The two semi-circles intersect at R. If $\angle PRQ = 30$ degrees, determine the size of $\angle ARD$.

END OF PROBLEM SET 1

CLOSING DATE FOR RECEIPT OF SOLUTIONS :

1 November 2024

Look out for Problems 2 in late November!

SEE OVER FOR LINKS TO THE MATHS CHALLENGES ARCHIVES

SMC

Mathematical Challenge Problems 1

JUNIOR DIVISION 2024-2025

PLEASE USE CAPITALS TO COMPLETE

SURNAME	
OTHER NAME(S) (underline the one you prefer)	
SCHOOL	
AGE	YEAR OF STUDY S

FOR OFFICIAL USE

Marker

Marks

1	2	3	4	5

Total	

– – – – - CUT ALONG HERE – – – –

Please write your solutions on A4 paper and staple the above form to them.
PLEASE WRITE YOUR NAME ON EVERY PAGE.
Send your entry through your school to the section organiser.

For further information on the competition, please see the School Materials which have been distributed to schools. A copy of these Materials can be obtained from

http://www.wpr3.co.uk/MC/materials/index.html

There are separate links for primary and secondary schools. This page also includes a list of authorities in each section and names and addresses of section organisers.

For information about Mathematical Challenge, look on the MC web site:

www.scot-maths.co.uk

MATHS CHALLENGES ARCHIVES

There are archives of previous questions on: **www.wpr3.co.uk/MC-archive/J/index-J.html**

Here is a shortcut for your smartphone or tablet

The Scottish Mathematical Council

www.scot-maths.co.uk

MATHEMATICAL CHALLENGE 2024−2025

Entries must be the unaided efforts of individual pupils.
Solutions must include explanations and answers without explanation will be given no credit.
Do not feel that you must hand in answers to all the questions.

CURRENT AND RECENT SPONSORS OF MATHEMATICAL CHALLENGE ARE
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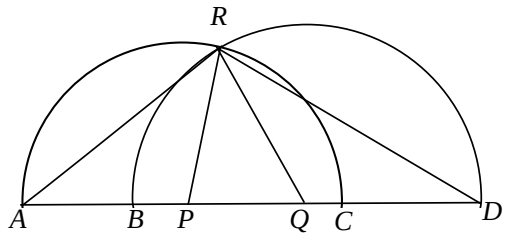
Particular thanks are due to the Universities of Aberdeen, Edinburgh Napier, Moray House, St Andrews, Stirling, Strathclyde and to George Heriot's School, Gryffe High School and Kelvinside Academy.

Middle Division: Problems 1

M1. A van delivering maths textbooks travels to a school at an average speed of 60mph. Due to a mechanical problem the van could only do the return journey at an average speed of 40mph.

What was the van's average speed over the entire journey?

M2.



In the diagram, points *B*, *P*, *Q* and *C* lie on line segment *AD*. The semi-circle with diameter *AC* has centre *P* and the semi-circle with diameter *BD* has centre *Q*. The two semi-circles intersect at *R*. If $\angle PRQ = 30$ degrees, determine the size of $\angle ARD$.

M3. A cross country track is in the form of a capital letter L.

The short side, which comes at the beginning of the race, is 2 miles long. When the runners have gone 1½ miles along the other side they are as far from the starting point (as the crow flies) as they are from the winning post.

How far (as the crow flies) is the distance from the starting point to the winning post?

M4. In the addition sum below, only one out of the five decimal points is in the correct position.

$$\begin{array}{r} 47.5 \\ 38.627 \\ 125.4 \\ 1583.3 \\ \hline 4508.57 \end{array}$$

Find all the possible ways to alter the four incorrect decimal places and make the sum add up correctly.

SEE OVER FOR QUESTION M5.

SMC

Mathematical Challenge Problems 1

MIDDLE DIVISION 2024-2025

PLEASE USE CAPITALS TO COMPLETE

SURNAME	
OTHER NAME(S) (underline the one you prefer)	
SCHOOL	
AGE	YEAR OF STUDY S

FOR OFFICIAL USE

Marker

Marks

1	2	3	4	5

Total	

– – – – - CUT ALONG HERE – – – –

Please write your solutions on A4 paper and staple the above form to them.
PLEASE WRITE YOUR NAME ON EVERY PAGE.
Send your entry through your school to the section organiser.

For further information on the competition, please see the School Materials which have been distributed to schools. A copy of these Materials can be obtained from

http://www.wpr3.co.uk/MC/materials/index.html

There are separate links for primary and secondary schools. This page also includes a list of authorities in each section and names and addresses of section organisers.

M5. When Oliver walks briskly down a downward moving escalator he takes 60 steps of the escalator to reach the bottom. When Oliver walks slowly down the escalator at half his previous speed he takes 42 steps of the escalator to reach the bottom. Assuming constant speeds for walking briskly, walking slowly and the movement of the escalator, find how many steps the escalator shows when it is stationary.

END OF PROBLEM SET 1

CLOSING DATE FOR RECEIPT OF SOLUTIONS :

1 November 2024

Look out for Problems 2 in late November!

For information about Mathematical Challenge, look on the MC web site:

www.scot-maths.co.uk

LINKS TO THE MATHS CHALLENGES ARCHIVES

There are archives of previous questions on: **www.wpr3.co.uk/MC-archive/M/index-M.html**

Here is a shortcut for your smartphone or tablet

The Scottish Mathematical Council

www.scot-maths.co.uk

MATHEMATICAL CHALLENGE 2024−2025

Entries must be the unaided efforts of individual pupils.
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The Scottish Mathematical Council is indebted to the above for their generous support and gratefully acknowledges financial and other assistance from schools, universities and education authorities.

Particular thanks are due to the Universities of Aberdeen, Edinburgh Napier, Moray House, St Andrews, Stirling, Strathclyde and to George Heriot's School, Gryffe High School and Kelvinside Academy.

Senior Division: Problems 1

S1. In the addition sum below, only one out of the five decimal points is in the correct position.

$$\begin{array}{r} 47.5 \\ 38.627 \\ 125.4 \\ 1583.3 \\ \hline 4508.57 \end{array}$$

Find all the possible ways to alter the four incorrect decimal places and make the sum add up correctly.

S2. When Oliver walks briskly down a downward moving escalator he takes 60 steps of the escalator to reach the bottom. When Oliver walks slowly down the escalator at half his previous speed he takes 42 steps of the escalator to reach the bottom. Assuming constant speeds for walking briskly, walking slowly and the movement of the escalator, find how many steps the escalator shows when it is stationary.

S3. Four cards with integers on are placed face down on a table. Five people in succession each take two cards and state the total value of the two cards, but do not reveal the individual values. These totals are

8, 13, 14, 17 and 11.

Determine the numbers on each of the four individual cards.

S4. Cyclic quadrilateral $ABCD$ has $AB = AD = 1$, $CD = \cos\angle ABC$ and $\cos\angle BAD = -\frac{1}{3}$.
Prove that BC is a diameter of the circumscribed circle.

S5. Choose 6 different non-zero digits.

(a) How many different 6 digit numbers can be formed from these 6 digits?

(b) Find the largest prime factor of the sum of all of these different 6 digit numbers.

END OF PROBLEM SET 1

CLOSING DATE FOR RECEIPT OF SOLUTIONS :

1 November 2024

Look out for Problems 2 in late November!

SEE OVER FOR LINKS TO THE MATHS CHALLENGES ARCHIVES

SMC

Mathematical Challenge Problems 1

SENIOR DIVISION 2024-2025

PLEASE USE CAPITALS TO COMPLETE

SURNAME	
OTHER NAME(S) (underline the one you prefer)	
SCHOOL	
AGE	
YEAR OF STUDY	S

FOR OFFICIAL USE

Marker

Marks

1	2	3	4	5

Total	

— — — — — — — — — — — — — — — — — —

C U T A L O N G H E R E

Please write your solutions on A4 paper and staple the above form to them.
PLEASE WRITE YOUR NAME ON EVERY PAGE.
Send your entry through your school to the section organiser.

For further information on the competition, please see the School Materials which have been distributed to schools. A copy of these Materials can be obtained from

http://www.wpr3.co.uk/MC/materials/index.html

There are separate links for primary and secondary schools. This page also includes a list of authorities in each section and names and addresses of section organisers.

For information about Mathematical Challenge, look on the MC web site:
www.scot-maths.co.uk

MATHS CHALLENGES ARCHIVES

There are archives of previous questions on: **www.wpr3.co.uk/MC-archive/S/index-S.html**

Here is a shortcut for your smartphone or tablet

The Scottish Mathematical Council

MATHEMATICAL CHALLENGE (SECONDARY)

Registration Fee 2024−2025

Participating schools are required to pay a registration fee. The fee covers both sets of problems. The secondary school fee is £20 for 1-10 entrants in Round 1, £15 for the next 10 (or part thereof) and so on. A cheque made payable to

SMC Mathematical Challenge

should be attached to this form (but see below) and

returned with the first set of problems.

School details	Name	. . . . .
	Telephone	. . . . .
	Address	. . . . .
		. . . . .
		. . . . .
		. . . . .
	Education Authority (where appropriate)	. . . . .
Contact teacher	Name	. . . . .
	email address (if used)	. . . . .

Payments: we prefer to be paid by cheque but if this is not possible we will accept payment by BACS. Our account is:

SMC MATHEMATICAL CHALLENGE

The details are: **83-06-08 1054 8147.**

The reference you provide **must** include the school postcode followed by the school name.

Data Protection

Our policy is attached. By completing and returning this form we will assume that you have read it and accept it.

Submission of scripts

You must submit **on time** and use **correct postage**. As a guide, first class large letters rates are:

Weight below	100g	250g	500g	750g
Postage	£2.10	£2.90	£3.50	£3.50

Data Protection and Privacy Policy for the SMC Maths Challenge

In the following, the data referred to is stored on the computer used for entering pupil and school details and for recording pupil performance. Access to all such information is password protected.

For each **entrant** the data stored is:

- surname, other name, school, year of study, and (after marking) the marks for each question. Permission to record this data is given by completing the tear-off form attached to the solutions.

For each **school** the data stored is:

- school name, address, phone, Primary or Secondary, LEA (Local Education Authority area), whether independent, contact teacher name and e-mail, and other information you want to add (if any).

Teachers have access, by logging in with their username and password, only to the data for their own school and its entrants, and are responsible for communicating results and awards to their entrants.

Section Organisers have access, by logging in with their username and password, only to data about schools and entrants within their own Section.

Designated members of the Maths Challenge National Committee have access, by logging in with their username and password, to all the data in the database to facilitate running the challenge.

No data will be kept for more than 4 years. This would allow for production of comparative reports over 3 years for the Scottish Mathematical Council Journal.

The data is stored on a secure server.

Contact: *scottishmathschallenge@gmail.com*

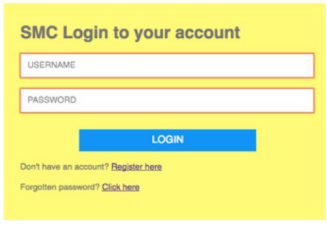
Last update: 16/8/24

Using the marks website

A Record of Entrants must be made on the marks website by the school or it will not be possible for the section organiser to later add the marks for each entrant.

Go to the website:

https://www.scottishmathschallenge.org.uk/

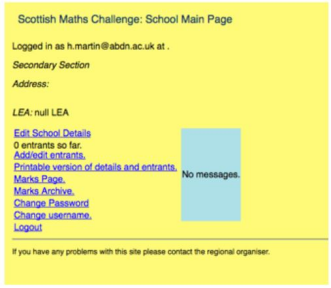


If you have used the website for your school in a previous year and can remember the username and password log in as usual.

Otherwise choose

"Register here"

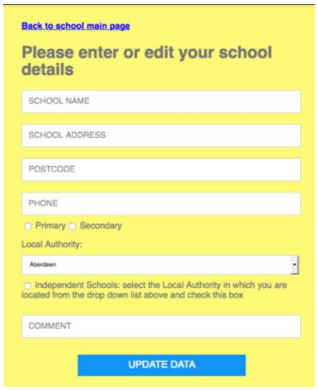
which enables you to enter your details and create a password. Your username will be your email address so please make sure that you enter this correctly. The system will send you an email with an activation link: click on this link to verify your email address and then log in.



You will need your username and password each time you log in.

Once logged in click on the link

"Edit School Details"



Check that all the contact details are correct, making changes as necessary. In particular, make sure that you select primary or secondary and the relevant local authority whenever you make changes.

Later, when you have a pile of entries, or a list of entrants, log in again and go to

"Add/Edit Entrants"

and enter

- the division (only for secondary pupils),
- the names, and
- the school year of each entrant.

When all your entrants have been added, to get a printout to send with your entries go to

"Printable version of details and entrants"

When the marks for each round are released, to view the marks for your school go to

"Marks page"

On the main page after you log in you may, from time to time, see messages from the section organisers.

NOTE: If you experience difficulties with the website please contact either

your section organiser or

Helen Martin h.martin@abdn.ac.uk

The Scottish Mathematical Council

www.scot-maths.co.uk

MATHEMATICAL CHALLENGE 2024–2025

Four explorers wish to get one of their number as far as possible into the wilderness from their base. Each explorer can carry supplies for up to 10 days. At any time supplies can be transferred between explorers and individual explorers can return to base, provided they have sufficient supplies for the return journey. Supplies cannot be left unattended in the wilderness.

What is the greatest number of days the lead explorer can travel from the base so that all return safely?

Ask your teacher for details of the new competition problems.

MATHEMATICAL CHALLENGE

2023–2024

Did you solve it?

One of the highlights of the local village social life is the stage production organised by the Amateur Youth Players and the rehearsals are in full swing for *The Gondoliers*. When I called the treasurer the other day he was estimating the costs. The first scene, in case you have forgotten, shows 24 maidens of Venice making up small bunches of red and white roses. He had intended that each girl would have three red and two white roses until he realised that the red roses cost twice as much each as the white ones. He decided to give half the girls three red and two white roses each and the remainder two red and three white roses. He had cut the cost by £3. How much is a red rose?

Solution

Let the cost of a red rose be £R and of white rose be £W.

12 girls had three red roses and two white roses so the cost of these is £$(36R + 24W)$.

The other 12 girls had two red roses and three white roses so the cost of these is £$(24R + 36W)$.

Originally the cost would have been £$(72R + 48W)$ and the new cost is £$(60R + 60W)$.

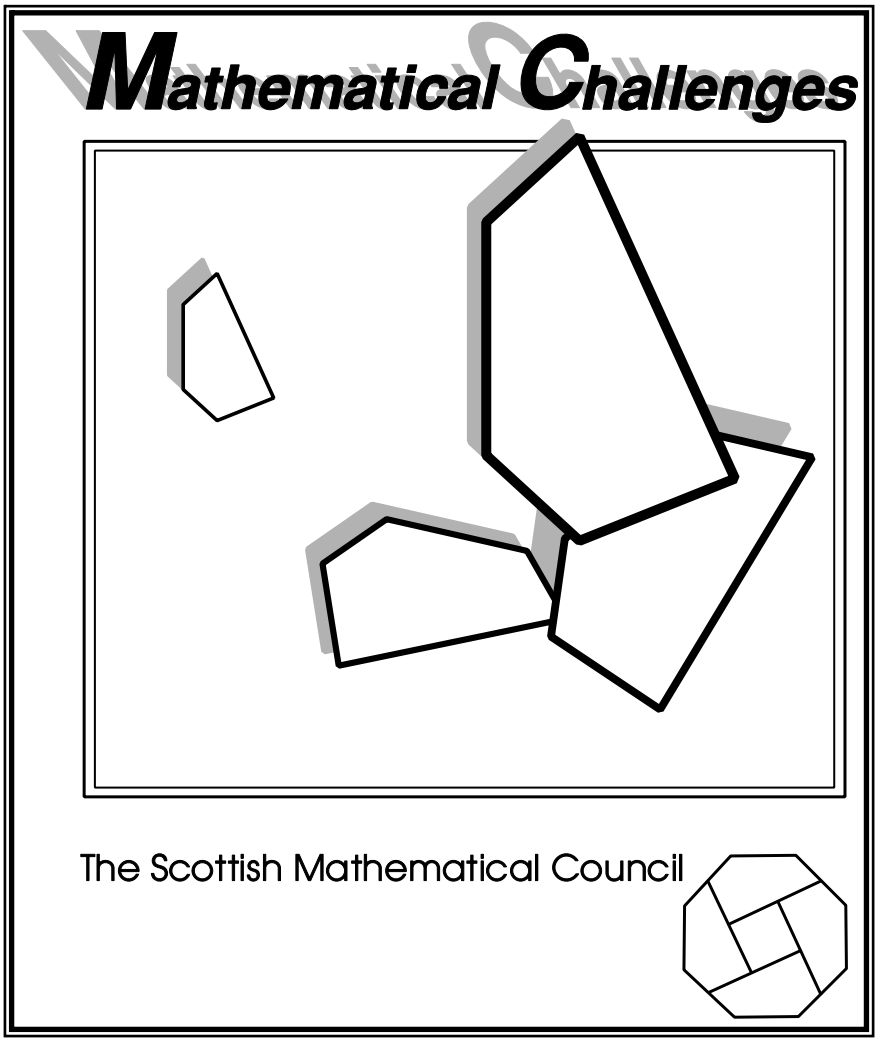
So the saving is $(72R + 48W) - (60R + 60W) = 12R - 12W = 3$.

But $W = \frac{1}{2}R$ so

$$12R - 12\left(\tfrac{1}{2}R\right) = 3$$

$$6R = 3.$$

Hence the cost of a red rose is 50 pence.



Archives and Books

The books listed below and there are still limited stocks. However, since 2006, an online archive has been developed. It covers all Challenges, with sheets with questions and separate sheets which include solutions. These are all available at

www.wpr3.co.uk/MC-archive/

The books which were published are as follows:

		Price	Number	Cost
Mathematical Challenges VI	2003 to 2006	£8.00		
Mathematical Challenges V	2000 to 2003	£8.00	_____	_____
Mathematical Challenges IV	1997 to 2000	£8.00	_____	_____
Mathematical Challenges III	1994 to 1997	£7.50	_____	_____
Primary Mathematical Challenges	up to 2001	£5.00	_____	_____
		Total		_____

Copies of any of these can be obtained from

Bill Richardson, Kintail, Longmorn, Elgin IV30 8RJ

Cheques with order are preferred.

Cheques should be made payable to 'SMC Mathematical Challenge'.

A few copies of Mathematical Challenges II and also the original Blackie Mathematical Challenges are still available.

email enquiries:- wpr3145@gmail.com