

Secondary Mathematical Challenges

Welcome to the 2018-2019 Scottish Secondary Mathematical Challenges. This package contains

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

In 2018-2019, 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 William Turner (w.turner@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
Dr Lotte Hollands (l.hollands@hw.ac.uk)
Mathematical Challenge, Department of Mathematics,
Heriot Watt University, Edinburgh EH14 4AS

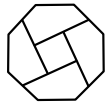
Section 4

Argyll & Bute; Dumfries & Galloway; East Ayrshire; East Dunbartonshire;
East Renfrewshire; Glasgow City; Inverclyde; North Ayrshire; North Lanarkshire;
Renfrewshire; South Ayrshire; South Lanarkshire; West Dunbartonshire
Dr Chris Athorne (christopher.athorne@glasgow.ac.uk)
Department of Mathematics, University of Glasgow, University Place, Glasgow G12 8QQ

The competition timetable for 2018-2019 is as follows:

<i>Set</i>	<i>Last date for receipt of questions by schools</i>	<i>Last date for receipt of solutions from pupils</i>
<i>I</i>	Friday 24 August 2018	Friday 28 September 2018
<i>II</i>	Friday 23 November 2018	Friday 22 February 2019

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 2018–2019

A national problem solving competition for schools in Scotland

SECONDARY DIVISIONS

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 S1 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 £16 for the first 10 entrants and half this amount 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.** Contestants 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 2018-2019 is as follows:

<i>Set No.</i>	<i>Last date for receipt of questions by schools</i>	<i>Last date for receipt of solutions from pupils</i>
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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 £6, £7.50, £8, £8, £8 respectively.

In addition, it seems unlikely that any further books will be printed so questions and solutions for 2006-2011 can be accessed at: www.wpr3.co.uk/MC-archive/

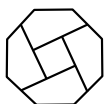
Comments on the usefulness of these to wpr3145@gmail.com would be welcome.

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 2018–2019

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, Professor L E Fraenkel,
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, Glasgow, Heriot Watt, St Andrews, Stirling, Strathclyde and to George Heriot's School, Gryffe High School, Kelvinside Academy and Northfield Academy.

Junior Division: Problems 1

J1. Early on a very hot day, a greengrocer places 20 kilograms of courgettes on display outside his shop. At that moment, the courgettes are 99% water. It turns out to be the hottest day of the year, and as a result, the courgettes dry out a bit. At the end of the day, the greengrocer has not sold a single courgette, and the courgettes are only 98% water. What weight of courgettes does he have at the end of the day?

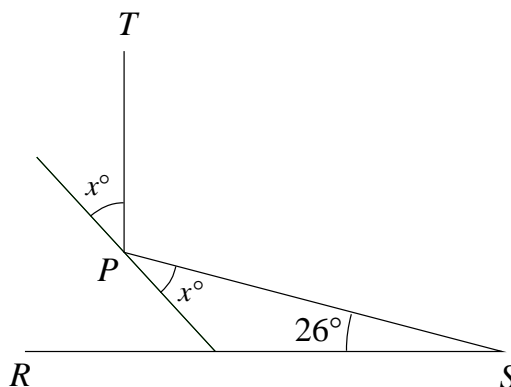
J2. On a coastline there are three lighthouses.
The first light shines for 3 seconds, then is off for 3 seconds.
The second light shines for 4 seconds, then is off for 4 seconds.
The third light shines for 5 seconds, then is off for 5 seconds.
All three lights have just come on together.

When is the first time that all three lights will be off?

When is the next time that all three lights will come on at the same moment?

J3. Two people are jogging back and forth on a straight road between two places which are 11 miles apart. One jogs at 5 miles per hour and the other at 6 miles per hour. They set off from opposite ends of the road at the same time. Determine where they are when they meet for the second time and how long it has taken them.

J4. A beam of light shines from point S , reflects off a reflector at point P , and reaches point T so that PT is perpendicular to RS and $\angle RSP = 26^\circ$ as shown below. Find angle x° .



SEE OVER FOR QUESTION J5.



Mathematical Challenge Problems 1

JUNIOR DIVISION 2018-2019

PLEASE USE CAPITALS TO COMPLETE

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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 organisers.

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.

- J5.** Emma started with a rectangle of paper. With one straight cut she divided it into a rectangle and a square. She took the rectangle and with one straight cut divided it into a rectangle and a square, which was smaller than the previous one. She kept repeating this process until eventually the final rectangle was a square with sides 1 centimetre and she was left with a pile of squares of paper. The average area of the squares was a two digit number of square centimetres.

What were the dimensions of the original rectangle?

END OF PROBLEM SET 1

CLOSING DATE FOR RECEIPT OF SOLUTIONS :

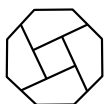
28 September 2018

Look out for Problems 2 in early December!

Look on the SMC web site:

www.scot-maths.co.uk

for information about Mathematical Challenge



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MATHEMATICAL CHALLENGE 2018–2019

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CURRENT AND RECENT SPONSORS OF MATHEMATICAL CHALLENGE ARE

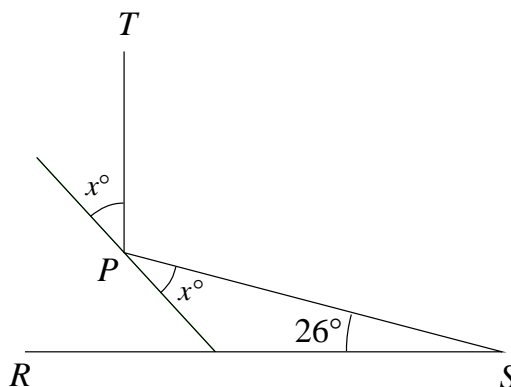
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Middle Division: Problems 1

- M1.** A beam of light shines from point S , reflects off a reflector at point P , and reaches point T so that PT is perpendicular to RS and $\angle RSP = 26^\circ$ as shown below. Find angle x° .



- M2.** Emma started with a rectangle of paper. With one straight cut she divided it into a rectangle and a square. She took the rectangle and with one straight cut divided it into a rectangle and a square, which was smaller than the previous one. She kept repeating this process until eventually the final rectangle was a square with sides 1 centimetre and she was left with a pile of squares of paper. The average area of the squares was a two digit number of square centimetres.

What were the dimensions of the original rectangle?

- M3.** A party of 30 villagers decided to hire a bus to take them to a show in the city. The tickets for the show cost 50p for children, £2.50 for pensioners and £5 for others. The number of "others" attending was more than the number of children but less than twice the number of children. There were more children than pensioners on the bus.

The total cost of the tickets was £100. How many children and how many pensioners attended the show?

- M4.** Three expert logicians played a game with a set of 21 cards each with a different two-digit prime number. Each drew a card and held it up so that they could not see the number on their own card but could see the number on the cards of each of the others. Ali, Bobby and Charlie in turn were then asked two questions, namely "Is your number the smallest of the three?" and "Is your number the largest of the three?". In the first round all three answered "Don't know" to both questions. The same happened in rounds two and three. In round 4 Ali answered "Don't know" to the first question. What did Ali answer to the second question and what numbers did Bobby and Charlie have?

SEE OVER FOR QUESTION M5.



Mathematical Challenge Problems 1

MIDDLE DIVISION 2018-2019

PLEASE USE CAPITALS TO COMPLETE

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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.** Consider a square with side 15 cm and an equilateral triangle with the same perimeter.
Which has the greater area? And by how much?

END OF PROBLEM SET 1

CLOSING DATE FOR RECEIPT OF SOLUTIONS :

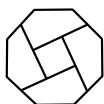
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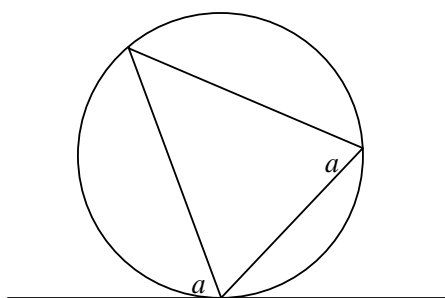
Senior Division: Problems 1

- S1.** Three expert logicians played a game with a set of 21 cards each with a different two-digit prime number. Each drew a card and held it up so that they could not see the number on their own card but could see the number on the cards of each of the others. Ali, Bobby and Charlie in turn were then asked two questions, namely "Is your number the smallest of the three?" and "Is your number the largest of the three?". In the first round all three answered "Don't know" to both questions. The same happened in rounds two and three. In round 4 Ali answered "Don't know" to the first question. What did Ali answer to the second question and what numbers did Bobby and Charlie have?

- S2.** Consider a square with side 15 cm and an equilateral triangle with the same perimeter. Which has the greater area? And by how much?

- S3.** (i) Prove the alternate segment theorem, which states that the angle between the tangent and chord at the point of contact is equal to the angle in the alternate segment.

- (ii) Two circles touch internally at M . A straight line touches the inner circle at P and cuts the outer circle at Q and R . Prove that $\angle QMP = \angle RMP$.



- S4.** Find all the positive integers k for which $7 \times 2^k + 1$ is a perfect square.

SEE OVER FOR QUESTION S5.



Mathematical Challenge Problems 1

SENIOR DIVISION 2018-2019

PLEASE USE CAPITALS TO COMPLETE

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- S5.** My husband and I recently attended a party at which there were four other married couples. No one shook hands either with themselves or with their spouse and no one shook hands with the same person more than once. After all the handshakes were over, I asked each person, including my husband, how many hands they had shaken. To my surprise each gave a different answer. How many hands did my husband shake?

END OF PROBLEM SET 1

CLOSING DATE FOR RECEIPT OF SOLUTIONS :

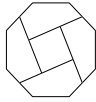
28 September 2018

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www.scot-maths.co.uk

for information about Mathematical Challenge



The Scottish Mathematical Council

MATHEMATICAL CHALLENGE (SECONDARY)

Registration Fee 2018–2019

Participating schools are required to pay a registration fee. The fee covers both sets of problems. The secondary school fee is £16 for 1-10 entrants in Round 1, £8 for the next 10 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.

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*

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

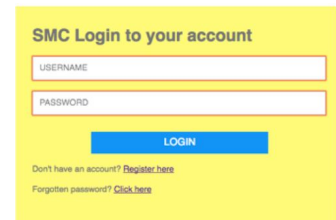
"Printable version of details and entrants"

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



SMC Login to your account

USERNAME

PASSWORD

Don't have an account? [Register here](#)

Forgotten password? [Click here](#)



Scottish Maths Challenge: School Main Page

Logged in as h.martin@abdn.ac.uk at .

Secondary Section

Address:

LEA: null LEA

[Edit School Details](#)

[0 entrants so far](#)

[Add/edit entrants](#)

[Printable version of details and entrants](#)

[Marks Page](#)

[Marks Archive](#)

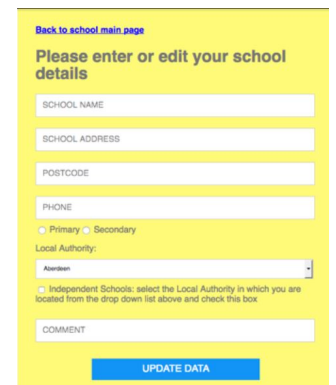
[Change Password](#)

[Change username](#)

[Logout](#)

No messages.

If you have any problems with this site please contact the regional organiser.



[Back to school main page](#)

Please enter or edit your school details

SCHOOL NAME

SCHOOL ADDRESS

POSTCODE

PHONE

Primary Secondary

Local Authority:

* Independent Schools: select the Local Authority in which you are located from the drop down list above and check this box.

COMMENT

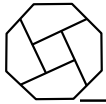


Entrant List:

Division	First Name	Surname	Year	Action
Add New:				
Primary	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="button" value="Add Entrant"/>

[Back to school main page.](#)

If you have any problems with this site please contact the regional organiser.



The Scottish Mathematical Council

www.scot-maths.co.uk

MATHEMATICAL CHALLENGE

2018–2019



On a coastline there are three lighthouses. The first light shines for 3 seconds, then is off for 3 seconds.

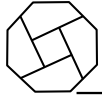
The second light shines for 4 seconds, then is off for 4 seconds.

The third light shines for 5 seconds, then is off for 5 seconds.

All three lights have just come on together. When is the first time that all three lights will be off?

When is the next time that all three lights will come on at the same moment?

See your teacher for details of the competition problems.



The Scottish Mathematical Council

www.scot-maths.co.uk

MATHEMATICAL CHALLENGE

2017–2018

Did you solve it?

Jonas travels 26 miles in 3 hours, partly on foot and partly by bike. He walks at 4 mph and cycles at 12mph.

For what length of time does Jonas walk?

How far does he cycle?

Solution

If Jonas walked for 3 hours, he would cover 12 miles.

So, he need to make up 14 miles by cycling. His extra speed is 8mph and at that speed he would need to travel $1\frac{3}{4}$ hours to cover 14 miles.

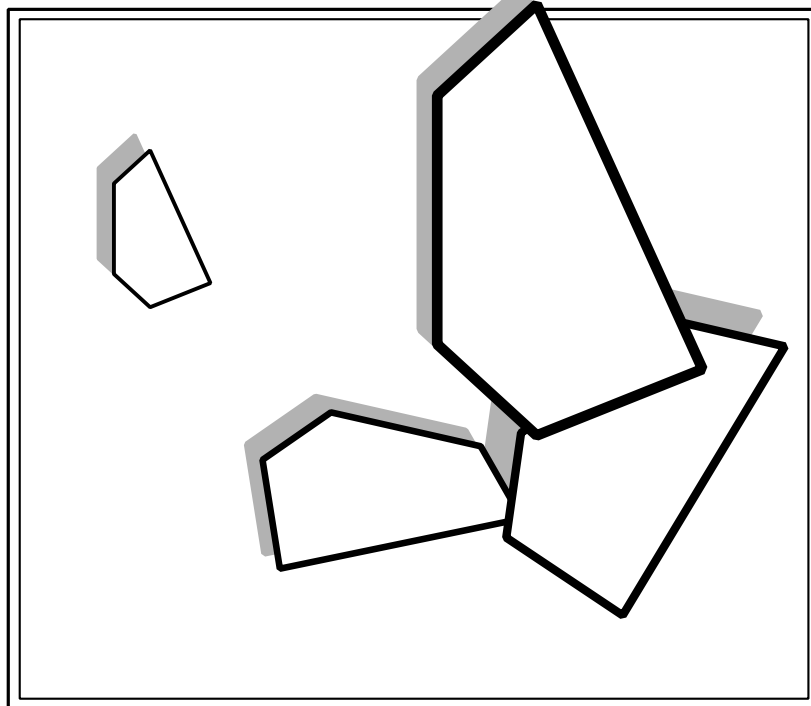
So he must walk for $1\frac{1}{4}$ hours and cycle for $1\frac{3}{4}$ hours.

Check: $1\frac{1}{4} \times 4 = 5$; $1\frac{3}{4} \times 12 = 21$ and $5 + 21 = 26$ as required.

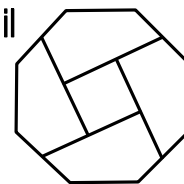
There is a second solution available on the Maths Challenge website:

See your teacher for details of the competition problems.

Mathematical Challenges VI



The Scottish Mathematical Council



Mathematical Challenges VI	2003-2006	£8.00 ×	_____	_____
Mathematical Challenges V	2000-2003	£8.00 ×	_____	_____
Mathematical Challenges IV	1997-2000	£8.00 ×	_____	_____
Mathematical Challenges III	1994-1997	£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'.

email enquiries:- wpr3145@gmail.com

Your name and address:
