

# INTERNATIONAL GCSE

## Mathematics (Specification B) (9-1)

EXEMPLARS WITH EXAMINER COMMENTARIES

PAPER 1

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Pearson Edexcel International GCSE in Mathematics (Specification B) (4MB1)

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# Contents

<b>Introduction</b>	<b>1</b>
<b>1.1 About this booklet</b>	<b>1</b>
<b>1.2 How to use this booklet</b>	<b>1</b>
<b>1.3 Further support</b>	<b>1</b>
<b>Question 15</b>	<b>2</b>
Exemplar response A	<b>3</b>
Exemplar response B	<b>3</b>
<b>Question 18</b>	<b>4</b>
Exemplar response A	<b>5</b>
Exemplar response B	<b>6</b>
<b>Question 19</b>	<b>7</b>
Exemplar response A	<b>7</b>
Exemplar response B	<b>8</b>
<b>Question 21</b>	<b>9</b>
Exemplar response A	<b>9</b>
Exemplar response B	<b>10</b>
<b>Question 22</b>	<b>11</b>
Exemplar response A	<b>12</b>
Exemplar response B	<b>13</b>
<b>Question 23</b>	<b>14</b>
Exemplar response A	<b>15</b>
Exemplar response B	<b>16</b>
<b>Question 24</b>	<b>17</b>
Exemplar response A	<b>18</b>
Exemplar response B	<b>19</b>
<b>Question 25</b>	<b>20</b>
Exemplar response A	<b>21</b>
Exemplar response B	<b>22</b>
<b>Question 26</b>	<b>23</b>
Exemplar response B	<b>25</b>
<b>Question 27</b>	<b>26</b>
Exemplar response A	<b>27</b>
Exemplar response B	<b>28</b>

# Introduction

## 1.1 About this booklet

This booklet has been produced to support teachers delivering the Pearson Edexcel International GCSE in Mathematics B (4MB1) specification. The Paper 1 exemplar materials will enable teachers to guide their students in the application of knowledge and skills required to successfully complete this course. The booklet looks at questions 15, 18, 19, 21, 22, 23, 24, 25, 26 and 27 from the June 2019 examination series, showing real candidate responses to questions and how examiners have applied the mark schemes to demonstrate how student responses should be marked.

## 1.2 How to use this booklet

Each example covered in this booklet contains:

- Question
- Mark scheme
- Exemplar responses for the selected question
- Example of the marker grading decision based on the mark scheme, accompanied by examiner commentary including the rationale for the decision and where relevant, guidance on how the answer can be improved to earn more marks.

The examples highlight the achievement of the assessment objectives at lower to higher levels of candidate responses.

Centres should use this content to support their internal assessment of students and incorporate examination skills into the delivery of the specification.

## 1.3 Further support

A range of materials are available from the Pearson qualifications website to support you in planning and delivering this specification.

Centres may find it beneficial to review this document in conjunction with: [the specification](#), [sample assessment materials](#), [Getting Started Guide](#) and [the Principal Examiner's Report](#).

## Question 15

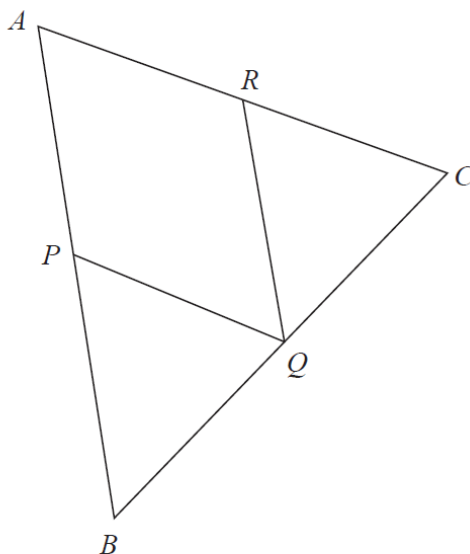


Diagram **NOT**  
accurately drawn

The diagram shows  $\triangle ABC$ .

$APQR$  is a parallelogram where  $P$  is the midpoint of  $AB$ ,  $Q$  is the midpoint of  $BC$  and  $R$  is the midpoint of  $AC$ .

Prove that  $\triangle PBQ$  and  $\triangle RQC$  are congruent.

(Total for Question 15 is 3 marks)

### Mark scheme

15	Side/Angle	Reason			
	$BQ = QC$	$Q$ is <b>midpoint/bisection</b> of $BC$			M1 Identifying a pair of equal sides/angles with a reason. They must state the pair of sides/angles and the reason must include the words in bold.
	$PQ = RC$	$AR = RC$ and $AR = PQ$ (opposite side of a <b>parallelogram</b> are equal)			
	$QR = BP$	$AP = PB$ and $AP = RQ$ (opposite side of a <b>parallelogram</b> are equal)			
	$\angle PBQ = \angle RQC$	<b>Corresponding</b> angles			M1 identifying a second relevant pair of equal sides/angles with a reason. They must state the pair of sides/angles and the reason must include the words in bold.
	$\angle BQP = \angle QCR$	<b>Corresponding</b> angles			
	$\angle BPQ = \angle QRC$	$\angle BPQ = \angle PQR$ and $\angle PQR = \angle QRC$ <b>Alternate angles or</b> $\angle APQ = \angle ARQ$ & angle on a <b>straight line</b>			
			SSS or SAS or ASA or AAS with the third relevant angle or side shown to be equal.	3	A1 must state SSS, SAS, ASA or AAS and have all 3 relevant sides/angles shown to be equal  <b>NB</b> There may be alternative reasons. Look for at least 1 correct mathematical word for each pair

## Exemplar response A

$$\begin{aligned} &\therefore AR = PQ \text{ (sides of parallelogram)} \\ \frac{BC}{2} &= BQ = QC \text{ (mid point is } Q, \text{ dividing } BC \text{ into 2)} \\ \frac{AC}{2} &= AR = RC \text{ (R = mid point)} \\ \frac{AB}{2} &= AP = PB \text{ (P is midpoint)} \\ &\therefore \text{AP and AR } \cancel{RQ} \text{ } PQ = RC, PB = RQ \text{ and} \\ &BQ = QC \text{ ; thus both } \Delta P B Q \text{ and} \\ &\Delta R Q C \text{ are} \\ &\text{congruent, SSS hence} \\ &\text{proven.} \end{aligned}$$

### Examiner's comments:

This response was given 2 marks.

M1:  $BQ = QC$  has been stated with a correct reason including the word midpoint.

M1:  $PQ = RC$  has been stated. For the reason, we can see  $AR = RC$  and  $AR = PQ$  with a correct reason including the words parallelogram.

A0: SSS is stated as is  $PQ = PR$ . However, the reason does not include the required detail. There is  $AP = PB$  but they have not stated  $AP = RQ$  with a reason.

## Exemplar response B

$$\begin{aligned} BQ &= QC \text{ (Q is midpoint of BC)} & \frac{RC}{RA} &= \frac{CQ}{AB} = \frac{PB}{PA} \\ RQ &= PQ = AP = RQ \text{ (APQR is a parallelogram)} \\ &\therefore \Delta P B Q \text{ and } \Delta R Q C \text{ are congruent.} \end{aligned}$$

### Examiner's comments:

This response was given 1 mark.

M1:  $BQ = QC$  is stated and the reason includes the word midpoint.

M0A0: No other pairs of sides have been stated.

NB: A common error is to state  $PQ = RQ$  since it is a parallelogram presumably under the misbelief that all 4 sides of a parallelogram are equal.

## Question 18

There are 9 marbles in bag *A* and 11 marbles in bag *B*.

In bag *A*, there are 3 red marbles, 2 yellow marbles and 4 green marbles.

In bag *B*, there are 2 red marbles, 4 yellow marbles and 5 purple marbles.

Ted takes at random one marble from bag *A* and one marble from bag *B*.

Calculate the probability that the two marbles are **not** the same colour.

(Total for Question 18 is 4 marks)

### Mark scheme

18				<p>M1 One of <math>\frac{3}{9} \times \frac{2}{11}</math> or <math>\frac{2}{9} \times \frac{4}{11}</math></p> <p>or P( <i>R</i>, not <i>R</i>) i.e. <math>\frac{3}{9} \times \frac{9}{11}</math> accept <math>\left(\frac{3}{9} \times \frac{4}{11} + \frac{3}{9} \times \frac{5}{11}\right)</math></p> <p>or P( <i>Y</i>, not <i>Y</i>) i.e. <math>\frac{2}{9} \times \frac{7}{11}</math> accept <math>\left(\frac{2}{9} \times \frac{2}{11} + \frac{2}{9} \times \frac{5}{11}\right)</math></p> <p>or P( <i>G</i>, not <i>G</i>) i.e. <math>\frac{4}{9} \times 1</math> accept <math>\left(\frac{4}{9} \times \frac{2}{11} + \frac{4}{9} \times \frac{4}{11} + \frac{4}{9} \times \frac{5}{11}\right)</math></p>
	$\left(\frac{3}{9} \times \frac{2}{11}\right) + \left(\frac{2}{9} \times \frac{4}{11}\right)$			<p>M1 Or two of <math>\frac{3}{9} \times \frac{9}{11}</math> accept <math>\left(\frac{3}{9} \times \frac{4}{11} + \frac{3}{9} \times \frac{5}{11}\right)</math></p> <p>or <math>\frac{2}{9} \times \frac{7}{11}</math> accept <math>\left(\frac{2}{9} \times \frac{2}{11} + \frac{2}{9} \times \frac{5}{11}\right)</math></p> <p>or <math>\frac{4}{9} \times 1</math> accept <math>\left(\frac{4}{9} \times \frac{2}{11} + \frac{4}{9} \times \frac{4}{11} + \frac{4}{9} \times \frac{5}{11}\right)</math></p>
	$1 - \left(\left(\frac{3}{9} \times \frac{2}{11}\right) + \left(\frac{2}{9} \times \frac{4}{11}\right)\right)$			<p>M1dep on both previous method marks being awarded. Attempt at correct calculation (oe)</p>
		$\frac{85}{99}$	4	A1 oe awrt 0.86 awrt 86%

## Exemplar response A

$$\begin{aligned} \text{Bag A} \quad \text{Red} &= \frac{3}{9} = \frac{1}{3} & \text{Yellow} &= \frac{2}{9} & \text{Purple} &= \frac{4}{9} \\ \text{Bag B} \Rightarrow \text{Red} &= \frac{2}{11} & \text{Yellow} &= \frac{4}{11} & \text{Purple} &= \frac{5}{11} \end{aligned}$$
$$\begin{aligned} \text{Total probability} &= \left(\frac{1}{3} \times \frac{4}{11}\right) + \left(\frac{1}{3} \times \frac{5}{11}\right) + \left(\frac{2}{9} \times \frac{2}{11}\right) + \left(\frac{2}{9} \times \frac{5}{11}\right) \\ &+ \left(\frac{4}{9} \times \frac{2}{11}\right) + \left(\frac{4}{9} \times \frac{4}{11}\right) \\ &= \left(\frac{4}{33} + \frac{5}{33}\right) + \left(\frac{4}{99} + \frac{10}{99}\right) + \left(\frac{8}{99} + \frac{16}{99}\right) \\ &= \frac{9}{33} + \frac{14}{99} + \frac{24}{99} \\ &= \frac{27 + 14 + 24}{99} = \frac{27 + 38}{99} = \frac{65}{99} \end{aligned}$$

### Examiner's comments:

This response was given 2 marks.

M1: The student has the equivalent of  $\frac{3}{9} \times \frac{4}{11} + \frac{3}{9} \times \frac{5}{11}$  as part of their calculation.

M1: The student has more than the two terms in the main scheme so we are looking for two that are given in the notes.  $\frac{3}{9} \times \frac{4}{11} + \frac{3}{9} \times \frac{5}{11}$  and  $\frac{2}{9} \times \frac{2}{11} + \frac{2}{9} \times \frac{5}{11}$  are given.

M0 A0: Incorrect calculation given as  $\frac{4}{9} \times \frac{5}{11}$  is missing.

## Exemplar response B

Bag A = 9 , Bag B = 11

Bag A  
3/9 Red  
4/9 Yellow  
4/9 green

Bag B  
2/11 Red  
4/11 Yellow  
5/11 purple

$$\begin{aligned} &= \frac{2}{9} \times \frac{4}{11} = \left[ \frac{2}{9} \times \frac{3}{11} \right] + \left[ \frac{4}{9} \times \frac{4}{11} \right] + \left[ \frac{4}{11} \times \frac{3}{9} \right] + \left[ \frac{3}{9} \times \frac{3}{11} \right] \\ &= \frac{2}{33} + \frac{4}{99} + \frac{4}{33} + \frac{1}{11} = \frac{31}{99} \\ &= 0.313 \end{aligned}$$

$$0.313 / \frac{31}{99}$$

### Examiner's comments:

**This response was given 1 mark.**

M1: The student has  $\frac{2}{9} \times \frac{4}{11}$  as part of their calculation.

M0: The student has more than the two terms in the main scheme so we are looking for two that are given in the notes. None of these are given.

M0dep: The previous method mark is not awarded so this method mark is not awarded.

A0: Incorrect answer.

## Question 19

The period,  $T$  seconds, of a simple pendulum of length  $L$  metres is given by the formula

$$T = 6.28\sqrt{\frac{L}{g}}$$

$L = 1.32$  to 3 significant figures.

$g = 9.8$  to 2 significant figures.

Calculate the upper bound, to 3 significant figures, of  $T$ .

(Total for Question 19 is 4 marks)

### Mark scheme

19	UB of 1.32 is 1.325			B1 1.325 seen implied by correct answer
	LB of 9.8 is 9.75			B1 9.75 seen implied by correct answer
	$6.28\sqrt{\frac{1.325}{9.75}}$			M1 Subst in their $L > 1.32$ and $g < 9.8$
		2.32	4	A1 awrt 2.32

### Exemplar response A

$$\begin{array}{l}
 L = 1.320 \quad g = 9.80 \\
 \text{upper bound} = 1.325 \quad \text{upper bound} = 9.85 \\
 \text{lower bound} = 1.315 \quad \text{lower bound} = 9.75 \\
 \text{upper bound of } T = 6.28\sqrt{\frac{1.325}{9.75}} \\
 = 2.30
 \end{array}$$

#### Examiner's comments:

**This response was given 3 marks.**

B1B1: The candidate has written down both the upper and lower boundary for values so we can award B1B1 as both 1.325 and 9.75 are seen.

M1: Substituted  $L > 1.32$  and  $g < 9.8$ . In this case they are also the correct values.

A0: Answer is incorrect.

## Exemplar response B

$$T = 6.28 \sqrt{\frac{1.315}{9.75}}$$
$$T = 6.28 \sqrt{0.134}$$
$$T = 2.31.$$

### Examiner's comments:

**This response was given 1 mark.**

The student recognises that they need to use bounds.

B0: They have selected the incorrect bound. If, like in exemplar A, they had written down both bounds for 1.32, they could have gained this mark even though they used the wrong one.

B1: 9.75 is seen.

M0A0: They have substituted  $L < 1.32$

## Question 21


Make  $x$  the subject of

$$\frac{x}{3} - 5 = \frac{x + 2y}{3w - 2y}$$

Give your answer as a single fraction.

(Total for Question 21 is 4 marks)

### Mark scheme

21	$x(3w - 2y) - 15(3w - 2y) = 3(x + 2y)$ or $(3w - 2y)(x - 15) = 3(x + 2y)$			M1 Multiply through by $(3w - 2y)$ and 3 – not necessarily at the same time
	$3x + 2xy - 3xw = 24y - 45w$			M1 Collect $x$ terms on one side and other terms on the opposite side (indep of first M)
	$x(3 + 2y - 3w) = 24y - 45w$			M1 taking $x$ out as a common factor of an equation correctly
		$x = \frac{24y - 45w}{3 + 2y - 3w}$	4	A1 Final answer – or equivalent – but must a single fraction. The numerator and denominator need not be simplified. Do not ISW

### Exemplar response A

$$\frac{x-15}{3} = \frac{x+2y}{3w-2y}$$

$$\cancel{(3w-2y)}(x-15) = 3(x+2y)$$

$$3w(x-15) - 2y(x-15) = 3x + 6y$$

$$3wx - 45w - 2yx + 10y = 3x + 6y$$

$$\cancel{3wx - 2yx} - 3x = 6y - 10y$$

$$x(3w - 2y - 3) = 6y - 10y$$

$$x = \frac{-4y(3+5)}{3w-2y-3}$$

$$3wx - 2yx - 3x = 6y + 10y + 45w$$

$$x(3w - 2y - 3) = 16y + 45w$$

$$x = \frac{16y + 45w}{3w - 2y - 3}$$

### Examiner's comments:

This response was given 3 marks.

M1: The student has multiplied by  $(3w - 2y)$  and 3 correctly.

M1: The terms in  $x$  have been collected on one side (although there is a sign error, the intention is clear).

M1: The  $x$  has been taken out as a common factor.

A0: Incorrect answer.

### Exemplar response B

$$\begin{aligned} \frac{x-5}{3} &= \frac{x+2y}{3w-2y} \\ \frac{x-3(5)}{15} &= \frac{x+2y}{3w-2y} \\ (x-15)(3w-2y) &= 15(x+2y) \\ x(3w-2y) - 15(3w-2y) &= 15+30y \\ 3wx - 2xy - 45w + 30 &= 15 + 30y \\ (x-15)(3w-2y) &= 15+30y \\ x-15 &= \frac{15+30y}{3w-2y} \\ x &= \frac{15+30y}{3w-2y} + 15 \end{aligned}$$

### Examiner's comments:

This response was given 0 marks.

M0: Although the student has multiplied by  $(3w - 2y)$ , they have multiplied through by 15 rather than by 3.

M0: The  $x$  terms have not been collected on 1 side correctly as  $x$  on the RHS has disappeared rather than been moved to the LHS.

M0: The  $x$  has not been taken out as a common factor.

A0: Incorrect answer.

## Question 22

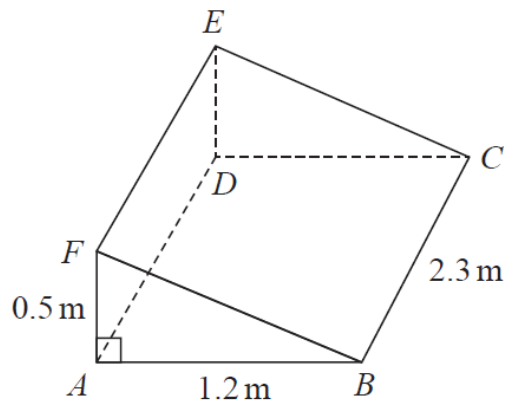


Diagram **NOT**  
accurately drawn

$ABCDEF$  is a right triangular prism in which

$$AB = 1.2 \text{ m} \quad BC = 2.3 \text{ m} \quad AF = 0.5 \text{ m} \quad \angle FAB = 90^\circ$$

Calculate the total surface area, in  $\text{m}^2$ , of the prism.

**(Total for Question 22 is 5 marks)**

### Mark scheme

22	$BF = \sqrt{0.5^2 + 1.2^2} \Rightarrow BF = 1.3$			M1 Award for $\sqrt{0.5^2 + 1.2^2}$ or 1.3 or correct method using trig to find an angle and then to find FB
	[Area of triangle $ABF$ (or $CDE$ )] = $0.5 \times 0.5 \times 1.2$ [=0.3] or [area of $ABF + DCE$ ] = $2 \times 0.5 \times 0.5 \times 1.2$ [=0.6]			M1 Allow use of $\frac{1}{2}ab \sin c$ with a correct method used to find the angle
	[Area of rectangle $ADEF$ ] = $0.5 \times 2.3$ [=1.15] <b>and</b> [Area of rectangle $ABCD$ ] = $1.2 \times 2.3$ [=2.76]			M1
	[Area of rectangle $BCEF$ ] = $2.3 \times "1.3"$ [=2.99]			M1 dep on 1 <sup>st</sup> M1 being awarded – allow their 1.3
		7.5	5	A1 cao

## Exemplar response A

$$\triangle AFB = \frac{1}{2} \times 0.5 \times 1.2 \times \sin 90$$

$$\begin{aligned} \text{area of } \triangle AFB &= \frac{1}{2} \times 1.2 \times 0.5 \\ &= 0.3 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} FB &= \sqrt{0.5^2 + 1.2^2} \\ &= 1.94 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Area of } BCEF &= 2.3 \times 1.94 \\ &= 4.462 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} \text{Area of } ADEF &= 0.5 \times 2.3 \\ &= 1.15 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} \text{Area of } ABCD &= 1.2 \times 2.3 \\ &= 2.76 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} \text{Total surface area} &= (0.3 \times 2) + 4.462 + 1.15 + 2.76 \\ &= \underline{\underline{8.97 \text{ m}^2}} \end{aligned}$$

### Examiner's comments:

This response was given 4 marks.

M1: The correct method for finding  $FB$  is shown. It does not need to be calculated correctly to gain this mark.

M1: The correct method for finding the area of the triangle is shown.

M1: The correct methods for both rectangles  $ADEF$  and  $ABCD$  are shown.

M1: The 1<sup>st</sup> method mark has been awarded so this mark **can** be awarded. The correct method for finding the area of  $ABCD$  has been shown using the length of "their  $FB$ ".

A0: Incorrect answer.

## Exemplar response B

surface area of prism = sum of areas of faces

$$\text{area of } \triangle FAB = \frac{0.5 \times 1.2}{2} = 0.3 \text{ m}^2$$
$$\text{area of } \triangle EDC = \triangle FAB = 0.3 \text{ m}^2$$
$$\text{area of } ABCD = 2.3 \times 1.2 = 2.76 \text{ m}^2$$

~~20~~

$$\text{area of } AFED = 0.5 \times 2.3 = 1.15 \text{ m}^2$$
$$\text{area of } FECD = 2.3 \times 1.2 = 2.76 \text{ m}^2$$
$$\text{area of prism} = 0.3 + 0.3 + 2.76 + 1.15 + 2.76 = 7.27 \text{ m}^2$$

### Examiner's comments:

**This response was given 2 marks.**

M0: The length of  $FB$  has not been found.

M1: The correct method for finding the area of the triangle is shown.

M1: The correct methods for both rectangles  $ADEF$  and  $ABCD$  are shown.

M0: The first method mark has not been awarded so this mark cannot be awarded.

A0: Incorrect answer.

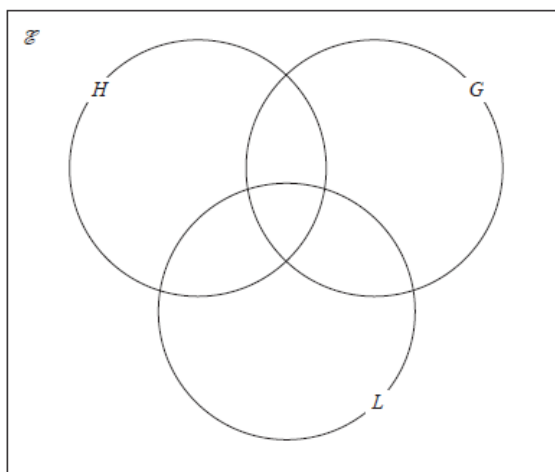
# Question 23

In a survey, 60 students were asked whether they study any of History ( $H$ ), Geography ( $G$ ) or Latin ( $L$ ).

Of these students

- 27 study History
- 25 study Geography
- 18 study Latin
- 13 study both History and Latin
- 2 study both Geography and Latin
- 8 study History only
- No students study History and Geography and Latin.

(a) Use the information to complete the Venn diagram.



(3)

(b) Find the number of students who study History but not Latin.

.....  
(1)

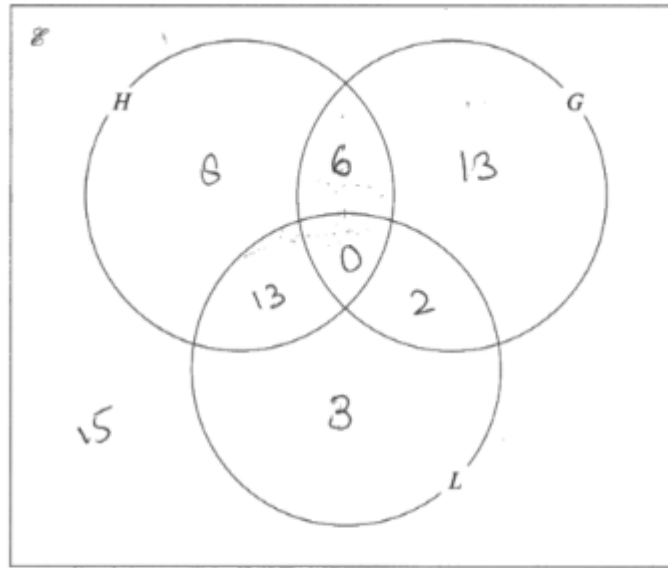
(c) Find  $n(H \cap [L \cup G])$

.....  
(1)

## Mark scheme

23	(a)			3	B3 for all 8 correct B2 for 6 or 7 correct B1 for 4 or 5 correct  If all other numbers are correct allow a blank for zero. Allow if written as a sum e.g. $18 - 2 - 13$ Do not allow entries in terms of a letter e.g. $x$
	(b)		14	1	B1ft Allow ft for "their 8" + "their 6" but do not award ft if one of the required areas is a blank or if in terms of $x$
	(c)		22	1	B1ft Allow ft for "their 17" + "their 2" + "their 3" but do not award ft if one of the required areas is a blank

## Exemplar response A



(3)

(b) Find the number of students who study History but not Latin.

14

(1)

(c) Find  $n(H' \cap [L \cup G])$

$$13 + 2 + 3$$

~~10 + 2 + 3~~

18

(1)

### Examiner's comments:

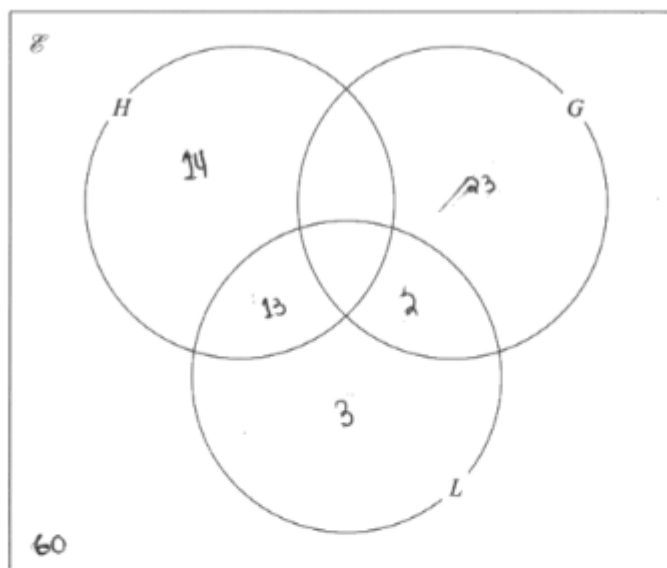
**This response was given 4 marks.**

(a) B2: six of the figures are correct.

(b) B1ft: correct answer.

(c) B1ft: correct answer following through "their 17", i.e.  $17 + 2 + 3 = 18$

## Exemplar response B



(3)

(b) Find the number of students who study History but not Latin.

13

(1)

(c) Find  $n(H' \cap [L \cup G])$

21

(1)

### Examiner's comments:

**This response was given 0 marks.**

- (a) B0: Three of the numbers 2, 3 and 13 are correct and a minimum of four are needed to award the mark. We do not allow a blank to mean zero unless all the other figures are correct. If zero had been in the middle, this would have scored B1.
- (b) B0ft: Incorrect answer.
- (c) B0ft: Incorrect answer following through "their 17" i.e.  $23 + 2 + 3$  means their answer should be 28.

## Question 24

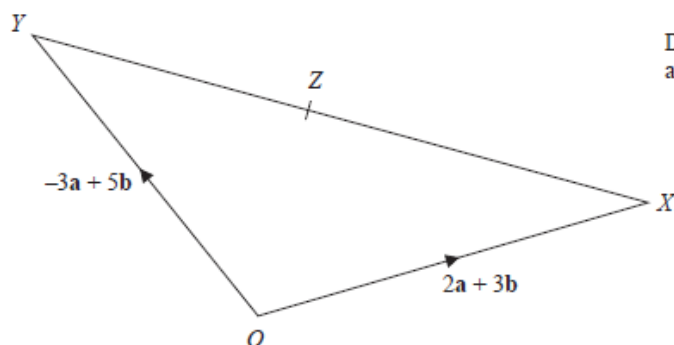


Diagram NOT  
accurately drawn

The diagram shows  $\triangle OXY$  where  $\vec{OX} = 2\mathbf{a} + 3\mathbf{b}$  and  $\vec{OY} = -3\mathbf{a} + 5\mathbf{b}$

(a) Find and simplify an expression, in terms of  $\mathbf{a}$  and  $\mathbf{b}$ , for  $\vec{YX}$ .

(2)

The point  $Z$  on  $YX$  is such that  $\vec{OZ} = -\frac{2}{9}\mathbf{a} + \frac{35}{9}\mathbf{b}$

(b) Calculate, in its simplest form, the ratio of  $YZ:ZX$

(3)

(Total for Question 24 is 5 marks)

### Mark scheme

24	(a)	$\vec{YX} = \vec{YO} + \vec{OX}$ or $\vec{YX} = \vec{OX} - \vec{OY}$ or $3\mathbf{a} - 5\mathbf{b} + 2\mathbf{a} + 3\mathbf{b}$			M1 do not accept $\vec{XY}$
			$5\mathbf{a} - 2\mathbf{b}$	2	A1 oe
	(b)	$[\vec{YZ} = \vec{OZ} - \vec{OY}] = \left(-\frac{2}{9}\mathbf{a} + \frac{35}{9}\mathbf{b}\right) - (-3\mathbf{a} + 5\mathbf{b})$ $[\vec{ZX} = \vec{ZO} + \vec{OX}] = \left(-\frac{2}{9}\mathbf{a} + \frac{35}{9}\mathbf{b}\right) + 2\mathbf{a} + 3\mathbf{b}$ $[\vec{ZX} = \vec{YX} - \vec{YZ}] = ("5\mathbf{a} - 2\mathbf{b}") - \left(\frac{25}{9}\mathbf{a} - \frac{10}{9}\mathbf{b}\right)$ $("5\mathbf{a} - 2\mathbf{b}") = k\left(\frac{20}{9}\mathbf{a} - \frac{8}{9}\mathbf{b}\right)$ $j("5\mathbf{a} - 2\mathbf{b}") = \left(\frac{20}{9}\mathbf{a} - \frac{8}{9}\mathbf{b}\right)$			M1 any 1 correct method. fit their $\vec{YX}$ from part a. and their $kZ$ in the 4/5 <sup>th</sup> line. May be implied by one of $\vec{YZ} = \frac{25}{9}\mathbf{a} - \frac{10}{9}\mathbf{b}$ $\vec{ZX} = \frac{20}{9}\mathbf{a} - \frac{8}{9}\mathbf{b}$ $k = \frac{4}{9}$ $j = \frac{9}{4}$
		$\vec{YZ} = \frac{25}{9}\mathbf{a} - \frac{10}{9}\mathbf{b} \text{ and } \vec{ZX} = \frac{20}{9}\mathbf{a} - \frac{8}{9}\mathbf{b}$ $\text{or } k = \frac{4}{9} \text{ or } j = \frac{9}{4}$			A1 accept decimals for fractions if meaning clear
			5:4	3	A1 Allow $\frac{5}{4}:1$ or $1:\frac{4}{5}$ or 1.25:1 or 1:0.8 do not allow $\frac{4}{5}\vec{YX} = \vec{ZX}$ oe

## Exemplar response A

$$\vec{YX} \Rightarrow -(-3a+5b) + 2a+3b.$$

$$\vec{YX} \Rightarrow 3a-5b+2a+3b.$$

$$\vec{YX} \Rightarrow 5a-2b$$

$$\frac{5a-2b}{\dots}$$

(2)

The point Z on YX is such that  $\vec{OZ} = -\frac{2}{9}\mathbf{a} + \frac{35}{9}\mathbf{b}$

(b) Calculate, in its simplest form, the ratio of YZ:ZX

$$\vec{ZX} = -\vec{OZ} + \vec{OX}$$

$$\vec{ZX} = -\left(-\frac{2}{9}\mathbf{a} + \frac{35}{9}\mathbf{b}\right) + 2a+3b.$$

$$\vec{ZX} = \frac{2}{9}\mathbf{a} - \frac{35}{9}\mathbf{b} + 2a+3b$$

$$\vec{ZX} = \frac{2}{9}\mathbf{a} + \frac{2a(9)}{9} - \frac{35\mathbf{b}}{9} + \frac{3b(9)}{9}$$

$$\vec{ZX} = \frac{20}{9}\mathbf{a} - \frac{8}{9}\mathbf{b}$$

$$\vec{YX} = k(\vec{ZX})$$

$$5a-2b = \frac{20a}{9} - \frac{8b}{9}$$

$$5a-2b = \frac{4}{9}(5a-2b).$$

$$\frac{4}{9} : 9$$

(3)

Here, YZ:ZX = 4:9

(Total for Question 24 is 5 marks)

### Examiner's comments:

This response was given 4 marks.

(a) M1A1: Correct answer.

(b) M1:  $\vec{ZX} = \frac{20}{9}\mathbf{a} - \frac{8}{9}\mathbf{b}$  is correct.

A1: Although not explicitly stated, they have written  $\vec{YX} = k\vec{ZX}$  have got  $k = \frac{4}{9}$

A0: Incorrect ratio given.

## Exemplar response B

$$\vec{YX} = \vec{YO} + \vec{OX}$$

$$\vec{YX} = -3a + 5b + 2a + 3b$$

$$\vec{YX} = -a + 8b$$

$$\frac{-a + 8b}{9}$$

(2)

The point Z on YX is such that  $\vec{OZ} = -\frac{2}{9}a + \frac{35}{9}b$

(b) Calculate, in its simplest form, the ratio of YZ:ZX

$$\vec{YZ} = \vec{YO} + \vec{OZ}$$

$$= \frac{-2}{9}a + \frac{35}{9}b + -3a + 5b$$

$$\vec{YZ} = -\frac{27}{9}a + \frac{80}{9}b$$

$$\vec{ZX} = \vec{ZO} + \vec{OX}$$

$$\vec{YZ} = -\frac{27}{9}a + \frac{80}{9}b$$

$$\vec{ZX} = \frac{20}{9}a - \frac{8}{9}b$$

$$\vec{YZ} = \frac{2}{9}a + \frac{35}{9}b + 2a + 3b$$

$$\vec{ZX} = \frac{20}{9}a - \frac{8}{9}b$$

$$\frac{-27}{9}a + \frac{80}{9}b = \frac{20}{9}a - \frac{8}{9}b$$

$$\frac{-27+80}{9} : \frac{20-8}{9}$$

(3)

### Examiner's comments:

This response was given 2 marks.

(a) M1:  $\vec{YX} = \vec{YO} + \vec{OX}$  is written.

A0: Incorrect answer.

(b) M1:  $\vec{ZX} = \frac{20}{9}a - \frac{8}{9}b$  is correctly written on RHS.

A0:  $\vec{YX}$  is incorrect.

A0: Incorrect ratio.

## Question 25

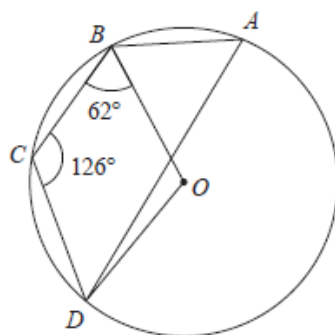


Diagram NOT accurately drawn

In the diagram,  $A$ ,  $B$ ,  $C$  and  $D$  are points on a circle, centre  $O$ .

$\angle CBO = 62^\circ$  and  $\angle BCD = 126^\circ$

(a) Find the size, in degrees, of  $\angle BAD$ .

Give a reason for your answer.

(2)

(b) Find the size, in degrees, of  $\angle ODC$ .

Give reasons for your working.

(4)

(Total for Question 25 is 6 marks)

### Mark scheme

25	(a)		54		B1
		e.g. The sum of the <b>opposite</b> angles in a <b>cyclic</b> quadrilateral is <b><math>180^\circ</math></b>	Reason	2	B1 need bold – other reasons may be given - must be associated with method used (see below for bold words)
	(b)	$\angle BOD = 108^\circ$			M1
		$360 - (108 + 126 + 62)$			M1ft their 108 but must be clear it is <i>BOD</i>
			64		A1
		Angle at <b>centre</b> of a circle is <b>twice</b> angle at the <b>circumference</b> or angles in a <b>quadrilateral</b> add up to <b><math>360^\circ</math></b> or angles at a <b>point</b> add up to <b><math>360^\circ</math></b>	Reason	4	B1 need one reason only and bold words – must be associated with method used
		<b>Alternative method marks 1</b> $\angle BCO = 62^\circ$			M1
		$\angle OCD = 126 - 62$			M1ft their 62 but must be clear it is <i>BCO</i>
			64		A1
		<b>Base(oe)</b> angles of an <b>isosceles</b> triangle are the same			B1 need bold words – must be associated with method used
		<b>Alternative method marks 2</b> Let $\angle ODA = y \therefore \angle ABO = "54"+ y$			M1ft Using their part (a)
		$\angle CDA = 360 - 126 - 62 - "54"- ("54"+ y)$			M1
			64		A1
		<b>Isosceles</b> triangle, angles in a <b>triangle</b> add up to <b><math>180^\circ</math></b> and angles in a <b>quadrilateral</b> add up to <b><math>360^\circ</math></b>	Reason		B1 need one reason only and bold words – must be associated with method used

## Exemplar response A

(a) Find the size, in degrees, of  $\angle BAD$ .

Give a reason for your answer.

$$180 - 126 = 54^\circ$$

Cyclic quadrilateral

$$\angle BAD = \frac{54}{(2)}^\circ$$

(b) Find the size, in degrees, of  $\angle ODC$ .

Give reasons for your working.

$$54 \times 2 = 108 \quad (\text{angle at the edge are twice the number at the center})$$

$$108 + 62 + 126 + \hat{D} = 360$$

$$296 + D = 360$$

$$D = 360 - 296$$

$$D = 64$$

(angle in a quadrilateral add up to  $360^\circ$ )

$$\angle ODC = \frac{64}{(4)}^\circ$$

### Examiner's comments:

**This response was given 4 marks.**

(a) B1: Correct angle.

B0: The reason is not complete as it is missing the word opposite and  $180^\circ$

(b) M1: Correct method to derive  $\angle BOD$

M1: Correct method to find  $\angle ODC$

A0: Incorrect answer.

B1: First reason given is incorrect (we are not allowing edge for circumference and also the reason is incorrect as it is reversed); second reason gains this mark.

## Exemplar response B

(a) Find the size, in degrees, of  $\angle BAD$ .

Give a reason for your answer.

$86^\circ$  ABCD is concyclic

$$\angle BAD = \underline{86}^\circ$$

(2)

(b) Find the size, in degrees, of  $\angle ODC$ .

Give reasons for your working.

$$BOD + BCD = 180$$

$$BOD + 126 = 180$$

$$BOD = 54$$

$$ODC = 360 - (126 + 62 + 54) = 118$$

$$\angle ODC = \underline{118}^\circ$$

### Examiner's comments:

**This response was given 1 mark.**

(a) B0: Incorrect angle.

B0: Incomplete reason.

(b) M0:  $\angle BOD$  is incorrect.

M1ft: A correct method is shown using "their  $\angle BOD$ ", which has been labelled clearly in working.

A0: No reasons given.

## Question 26

$$\mathbf{A} = \begin{pmatrix} 2 & 3 \\ -5 & 1 \end{pmatrix} \quad \mathbf{B} = \begin{pmatrix} 4 & k \\ 1 & -1 \end{pmatrix}$$

The determinant of the matrix  $\mathbf{A}^2 - \mathbf{AB}$  is equal to  $3k + 28$

Find the value of  $k$ .

(Total for Question 26 is 6 marks)

### Mark scheme

26	$\mathbf{A}^2 = \begin{pmatrix} -11 & 9 \\ -15 & -14 \end{pmatrix}$			M1 Condone one error
	$\mathbf{AB} = \begin{pmatrix} 11 & 2k-3 \\ -19 & -5k-1 \end{pmatrix}$			M1 Condone one error
	$\mathbf{A}^2 - \mathbf{AB} = \begin{pmatrix} -22 & 12-2k \\ 4 & 5k-13 \end{pmatrix}$			A1 cao
	$\det(\mathbf{A}^2 - \mathbf{AB}) = -22(5k-13) - 4(12-2k)$			M1 ft their $\mathbf{A}^2 - \mathbf{AB}$
	$-22(5k-13) - 4(12-2k) = 3k + 28$ $\Rightarrow k = \dots$			M1 dep on previous M1- Sets their determinant equal to $3k + 28$ and attempts to solve for $k$
		$k = 2$	6	A1

## Exemplar response A

$$A^2 - AB$$

$$A = \begin{pmatrix} 2 & 3 \\ -5 & 1 \end{pmatrix}$$

$$A^2 = \begin{pmatrix} 2 & 3 \\ -5 & 1 \end{pmatrix} \begin{pmatrix} 2 & 3 \\ -5 & 1 \end{pmatrix}$$

$$= \begin{pmatrix} 4-15 & 6+3 \\ -10-5 & -5+1 \end{pmatrix} = \begin{pmatrix} -11 & 9 \\ -15 & -4 \end{pmatrix}$$

$$AB = \begin{pmatrix} 2 & 3 \\ -5 & 1 \end{pmatrix} \begin{pmatrix} 4 & k \\ 1 & -1 \end{pmatrix}$$

$$= \begin{pmatrix} 8+3 & 2k-3 \\ -20+1 & -5k-1 \end{pmatrix} = \begin{pmatrix} 11 & 2k-3 \\ -19 & -5k-1 \end{pmatrix}$$

$$A^2 - AB = \begin{pmatrix} -11 & 9 \\ -15 & -4 \end{pmatrix} - \begin{pmatrix} 11 & 2k-3 \\ -19 & -5k-1 \end{pmatrix}$$

$$= \begin{pmatrix} -22 & 2k+12 \\ 4 & -5k-13 \end{pmatrix}$$

$$ad - bc = -22(-5k-13) - 2k+12(4)$$

$$= 110k + 286 - 8k + 48 = 3k + 28$$

$$110k - 8k = 28 - 48 - 286$$

$$102k = -306$$

$$k = -2.86$$

### Examiner's comments:

This response was given 4 marks.

M1:  $A^2$  is correct.

M1:  $AB$  is correct.

A0:  $A^2 - AB$  is incorrect (sign error).

M1ft: The expression for the determinant is correct using "their  $AB$ "

M1dep: Previous method mark awarded so this mark can be awarded. "Their determinant" has been equated to  $3k + 28$  and there has been an attempt to solve the equation.

A0: Incorrect answer.

## Exemplar response B

$$\begin{aligned} & \begin{pmatrix} 2 & 3 \\ -5 & 1 \end{pmatrix}^2 - \begin{pmatrix} 2 & 3 \\ -5 & 1 \end{pmatrix} \begin{pmatrix} 4 & k \\ 1 & -1 \end{pmatrix} \\ & \begin{pmatrix} 4 & 9 \\ 25 & 1 \end{pmatrix} - \begin{pmatrix} 2 \times 4 + 3 \times 1 & 2 \times k + 3 \times (-1) \\ -5 \times 4 + 1 \times 1 & -5 \times k + 1 \times (-1) \end{pmatrix} \\ & \begin{pmatrix} 4 & 9 \\ 25 & 1 \end{pmatrix} - \begin{pmatrix} 11 & 2k-3 \\ -19 & -5k-1 \end{pmatrix} \\ & \begin{pmatrix} -7 & 2k+12 \\ 44 & -5k+2 \end{pmatrix} \end{aligned}$$

### Examiner's comments:

This response was given 1 mark.

M0:  $\mathbf{A}^2$  is incorrect. The student has shown they know how to multiply by finding  $\mathbf{AB}$  correctly. The way this student has squared matrix A was commonly seen and resulted in the student losing two marks.

M1:  $\mathbf{AB}$  is correct.

A0:  $\mathbf{A}^2 - \mathbf{AB}$  is incorrect.

M0M0A0: No attempt has been found to find the determinant.

## Question 27

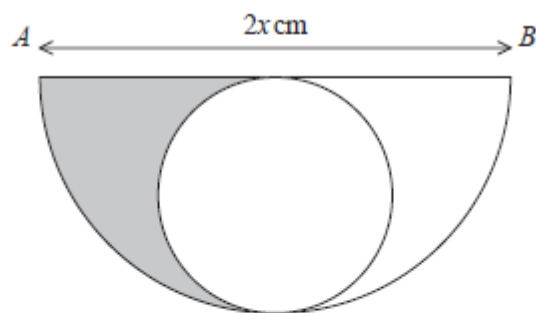


Diagram NOT accurately drawn

The diagram shows a semicircle, with diameter  $AB$ , where  $AB = 2x$  cm.

The diagram also shows a circle, which is the circle with the greatest possible radius that can be drawn inside the semicircle.

The perimeter of the shaded region is  $P$  cm and the area of the shaded region is  $A$  cm<sup>2</sup>.

Given that  $P = A$ , find an expression for  $x$  in terms of  $\pi$ .

(Total for Question 27 is 6 marks)

### Mark scheme

27	Area of large semicircle = $\frac{1}{2}\pi x^2$ <b>or</b> half large semicircle = $\frac{1}{4}\pi x^2$			M1
	Area of small circle = $\pi\left(\frac{x}{2}\right)^2$ <b>or</b> half small circle = $\frac{1}{2}\pi\left(\frac{x}{2}\right)^2$			M1
	Shaded region = $\frac{1}{2}\left(\frac{1}{2}\pi x^2 - \pi\left(\frac{x}{2}\right)^2\right)$ [= $\frac{1}{8}\pi x^2$ ]			A1
	Perimeter = $x + \frac{1}{4}(2\pi x) + \frac{1}{2}\left(2\pi\left(\frac{x}{2}\right)\right)$ [= $\pi x + x$ ]			M1
	" $\frac{\pi x^2}{8}$ " = " $\pi x + x$ "			M1 Equates their expressions for the perimeter and area of shaded region
		$x = \frac{8(\pi + 1)}{\pi}$	6	A1 Or equivalent

## Exemplar response A

$$\begin{aligned}
 \text{P of the } \frac{1}{2} \text{ circle} &= \pi r & r &= \frac{1}{2} x \\
 &= \pi x & &= \frac{\pi x}{2} \\
 \text{P of the } \frac{1}{2} \text{ semicircle} &= \frac{1}{2} \pi r & r &= x \\
 &= \frac{\pi x}{2} \\
 &= \frac{\pi x}{2} + \frac{\pi x}{2} + x \\
 P &= \pi x + x \\
 A &= \frac{1}{4} \pi r^2 & A \text{ of } \frac{1}{2} \text{ circle} &= \frac{1}{2} \pi r^2 \\
 &= \frac{1}{4} \pi (x)^2 & &= \frac{1}{2} \pi (\frac{1}{2} x)^2 \\
 &= \frac{x^2 \pi}{4} & &= \frac{1}{8} \pi x^2 \\
 &= \frac{x^2 \pi}{4} - \frac{1}{8} \pi x^2 \\
 A &= \frac{1}{8} \pi
 \end{aligned}$$

$$\begin{aligned}
 \pi x + x &= \frac{1}{8} \pi \\
 x(\pi + 1) &= \frac{1}{8} \pi \\
 x &= \frac{\pi}{8} / (\pi + 1)
 \end{aligned}$$

### Examiner's comments:

This response was given 5 marks.

M1: Area of half large semi-circle correctly stated.

M1: Area of half small circle correctly stated.

A1: The correct method for finding the shaded region is seen.

NB: The shaded region is the same as the area of the half small circle so **make** sure it comes from correct working, which it does here.

M1: Perimeter correctly stated at the start of their answer.

M1: Equated their expression for the perimeter (P) and the shaded area (A). We condone the simplification error of their expression for the area for this mark.

A0: The error made when simplifying the area results in an incorrect answer.

## Exemplar response B

$$\begin{aligned} \text{radius of semi circle} &= x \text{ cm} \\ \text{area of semi circle} &= \frac{1}{2}\pi x^2 \text{ cm}^2 \\ \text{diameter} &= x \\ \text{diameter of Circle} &= x \text{ cm} \\ \text{radius of Circle} &= \frac{1}{2}x \text{ cm} \\ \text{area of Circle} &= \pi \left(\frac{1}{2}x\right)^2 \\ &= \pi \times \frac{1}{4}x^2 \end{aligned}$$

### Examiner's comments:

**This response was given 2 marks.**

M1: The expression for area of larger semi-circle is correct.

M1: The expression for area of half small circle is correct in the expression for the shaded area.

A0: Student has not been able to use the area they have worked out to find the shaded area.

M0M0A0: The perimeter has not been found.

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