

# REVISE

*.wales*

## 3.12 – Perimeter, area, arcs & sectors

*Mark schemes for the 3.12 question pack*

*Spec 3.6.1, 3.6.2 – Unit 3*

SOLUTIONS · 2025 SPECIFICATION

*Mark schemes for the 38 questions in the corresponding revise.wales question pack (187 marks total). Sources: legacy WJEC GCSE papers, WJEC SAM, and custom-authored mark schemes. Pack layout © revise.wales.*

Autumn 2016			
8.	$BDC = 28(^{\circ})$ $BCD = 90(^{\circ})$  $BD = \frac{4.7}{\sin 28}$  $BD = 10(\dots)(\text{cm})$	✓ ✓  ✓✓ ✓	B1 B1  M2 A1  <u>Alternative method</u> $COB = 56(^{\circ})$ <span style="float: right;">B1</span> $OB = \frac{2.35}{\sin 28}$ <span style="float: right;">M2</span> (M1 for $\frac{2.35}{\sin 28}$ )  $OB = 5(\dots)(\text{cm})$ <span style="float: right;">A1</span> $BD = 10(\dots)(\text{cm})$ <span style="float: right;">A1</span>
	Organisation and Communication	✓	OC1 For OC1, candidates will be expected to: <ul style="list-style-type: none"> <li>• present their response in a structured way</li> <li>• explain to the reader what they are doing at each step of their response</li> <li>• lay out their explanation and working in a way that is clear and logical</li> </ul>
	Accuracy of writing	✓	W1 For W1, candidates will be expected to: <ul style="list-style-type: none"> <li>• show all their working</li> <li>• make few, if any, errors in spelling, punctuation and grammar</li> <li>• use correct mathematical form in their working</li> </ul> use appropriate terminology, units, etc.

14. (a) $\theta = (65 \times 360) / (10^2 \times \pi)$ $\theta = 74.48(^{\circ})$		M2 A1	Award M1 for $\theta = 360 \times \pi \times 10^2 = 65$ Accept answers in the range 74.47 to 74.53 or 74 or 75.
14. (b) $EF = (74.48/360) \times 2 \times \pi \times 10$ $= 13(\text{cm})$		M1 A1	FT their '74.48'. Accept answers between 12.9 and 13.1, truncated or rounded. Allow in terms of $\pi$ , e.g. $\frac{931}{225}\pi$  <u>Alternative (the major sector arc)</u> Allow $285.52/360 \times 2 \times \pi \times 10$ <span style="float: right;">M1</span> $= 49.8(3\dots)$ or $50(\text{cm})$ <span style="float: right;">A1</span>

<p>18. (a) Sight of <math>(360/18=) 20^\circ</math></p> <p><math>x^2 = 10^2 + 7^2 - 2 \times 10 \times 7 \times \cos 20^\circ</math></p> <p><math>x = 4.17(6\dots)</math> or <math>x = 4.2</math> or <math>x = 4.18</math></p> <p>Perimeter = <math>75(.17\dots \text{ cm})</math></p>	<p>✓</p>   <p>✓</p> <p>✓✓</p> <p>✓</p>	<p>B1</p>   <p>M1</p> <p>A2</p> <p>B1</p>	<p>May be seen in 18(a) or 18(b).</p>   <p>FT 'their <math>20^\circ</math>'</p> <p>A1 for <math>x^2 = 17.4(43\dots)</math></p> <p>FT 18x provided B1 and M1 awarded</p>
<p>18. (b) <math>\frac{1}{2} \times 10 \times 7 \times \sin 20^\circ</math></p> <p><math>= 11.97(07\dots \text{ cm}^2)</math> OR <math>12(\text{ cm}^2)</math></p> <p>(Area of star) = <math>215(.47\dots \text{ cm}^2)</math></p>		<p>M1</p> <p>A1</p> <p>A1</p>	<p>FT their angle from (a)</p>   <p>FT 18 × 'their 11.97...'</p>  <p><u>Alternative method (Area of a kite)</u></p> <p>Calculating shorter diagonal of the kite by using either:</p> <p><math>2 \times 7 \times \sin 20^\circ</math></p> <p>or (cosine rule) <math>\sqrt{(7^2 + 7^2 - 2 \times 7 \times 7 \times \cos 40^\circ)}</math></p> <p><math>= 4.78(828\dots \text{ cm}^2)</math></p> <p>Area of the kite:</p> <p><math>\frac{1}{2} \times 10 \times 4.78(828\dots)</math> <span style="float: right;">M1,</span></p> <p>FT 'their 4.78...'; provided there is evidence the shorter diagonal has been calculated correctly, e.g. using the 2 methods above.</p>  <p><math>= 23.94(141\dots)</math> <span style="float: right;">A1</span></p>  <p>(Area of star) = <math>215(.47\dots \text{ cm}^2)</math> <span style="float: right;">A1</span></p>

3(a) (Length) 6 (m) AND (width) 3 (m)	B2	Accept in either order in the answer space B1 for any 1 of the following: <ul style="list-style-type: none"> <li>• sight of <math>18 \div 3</math></li> <li>• sight of <math>18 \div 6</math></li> <li>• either length or width correct (any order)</li> <li>• answers 12 (m) and 6 (m) (any order)</li> <li>• <math>1x + 2x + 1x + 2x = 18</math> or similar</li> </ul>
3(b) $x + 3 + x + 3 + x + x = 16$ or $x + 3 + x = 8$ or equivalent  $4x + 6 = 16$ or $4x = 16 - 6$ or $4x = 10$ or $2x + 3 = 8$ or equivalent  (Length) 5.5 (m) and (width, x) 2.5 (m)	M1  m1  A1	Accept any variable for 'x'  Depends on the previous M1 This m1 implies the previous M1  CAO Needs to be in the correct order in the answer space, or clearly labelled <i>Alternative method to work with <math>y - 3</math> and <math>y</math> leading to <math>y = 5.5</math></i>  If no marks, allow SC1 for answers of 5.5(m) and 2.5(m) if no equation given or if 'their equation' not used to elicit these answers, OR SC1 for answers of 9.5(m) and 6.5(m) from sight of $x + x + 3 = 16$

4(a) 8	B1	
4.(b) States or implies 'No' with a reason, e.g. 'all Josef's patterns have an odd number of squares', 'same number on each branch from the one top square makes it an odd number', 'one square left over', 'one square short', 'one more needed', 'the arms would be unequal (in length)', '22 is even', 'P10 is (made using) 21 (squares), P11 is (made using) 23 (squares)', 'he would only be able to make a pattern with 21 squares'	E1	Do not accept 'No' with, e.g. 'too many squares', '22 is not part of the pattern', 'it is unequal'
4(c) P4	B2	Allow $P = 4$ B1 for sight of $10 \div 0.5$ or 20 (small square edges) or shows 5 squares on each side (stated or diagram in the answer space for (c)) B0 for P20 unless sight of $10 \div 0.5$ (which is awarded B1)

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10.	$360 - 2 \times 37$	$5$		M1	
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<p>11.(a) (Length of arc) <math>\frac{50}{360} \times 2 \times \pi \times 5</math>                  = 4.3(611...) to 4.4 (cm) OR <math>500\pi/360</math> (cm)                  Perimeter = 14.3(611...) to 14.4 (cm)</p>	<p>M1 A1 B1</p>	<p>Or <math>25\pi/18</math>. May be implied by B1                  FT for adding 10 providing M1 awarded</p>
<p>11.(b)                  (Area <math>\frac{1}{4}</math> circle =) 7.065 to 7.1 (<math>\text{cm}^2</math>) OR <math>9\pi/4</math>                  (Area sector =) <math>\frac{50}{360} \times \pi \times 5^2</math>                  = 10.9(027...) to 10.91 OR <math>125\pi/36</math> (<math>\text{cm}^2</math>)                  (Surface area of badge =)  <math display="block">7.06 \dots + 10.91 \dots - \frac{50}{360} \times \pi \times 3^2</math>                 (3.925 to 3.9275)                  = 14.0(427...) to 14.1 OR <math>161\pi/36</math> (<math>\text{cm}^2</math>)</p>	<p>B1 M1 A1 M1 A1</p>	<p>May be implied in further working                  May be implied in further working                  FT 'their 7.06...' and 'their 10.91...' provided previous M1 awarded                  Needs to come from values that are correct to at least 1 decimal place    <i>Alternative method:</i>                  B1 for <math>(\frac{20}{360} \times \pi \times 3^2)</math> 1.57 to 1.571 or <math>\pi/2</math> (<math>\text{cm}^2</math>)                  (may be implied in further working)                  M1 for <math>\frac{50}{360} \times \pi \times 5^2</math>                  A1 for 10.9(027...) to 10.91 OR <math>125\pi/36</math> (<math>\text{cm}^2</math>)                  M1 for <math>10.9 \dots + (2 \times \frac{20}{360} \times \pi \times 3^2)</math>                  FT 'their 10.9' and 'their 1.57' provided previous M1 awarded                  A1 for 14.0(427...) to 14.1 OR <math>161\pi/36</math> (<math>\text{cm}^2</math>)</p>

<p>14.(a) (Hyp of triangle =) <math>1 \div (\sin 7.1^\circ)</math>  <math>= 8.0(9051\dots)</math> or <math>8.1</math> (m)  <math>(AB^2 =) 5^2 + 8.0(9051\dots)^2</math>  <math>AB^2 = 90.4(564\dots)</math> or <math>(AB =) \sqrt{90.4(564\dots)}</math>  <math>(AB =) 9.5(108\dots)</math> (m)</p>	<p>M2 A1 M1 A1 A1</p>	<p>Or equivalent  M1 for <math>\sin 7.1^\circ = 1 \div</math> (Hyp of triangle)  Accept 8 (m) from correct working  FT their <math>8.0(9051\dots)</math> provided trigonometry attempted  FT their rounded <math>8.0(9051\dots)</math>  Do not accept <math>9.4</math>(m) from use of 8(m)  Needs to be correct to 1 d.p.  FT from previous M1 for the correctly evaluated square root of 'their <math>90.4(564\dots)</math>' provided 'their answer' &gt; 'their <math>8.09(051\dots)</math>'    <i>Alternative method:</i>  Base of triangle = <math>1/\tan 7.1</math> (= <math>8.0284\dots</math>) M1  <math>5^2 + 8.0(284\dots)^2</math> (= <math>89.456\dots</math>) M1  Base diagonal = <math>9.4(581\dots)</math> or <math>9.5</math> (m) A1  <math>1^2 + 9.4(581\dots)^2</math> M1  FT 'their rounded <math>9.4(581\dots)</math>'  <math>AB^2 = 90.4(564\dots)</math> or <math>(AB =) \sqrt{90.4(564\dots)}</math> A1  <math>(AB =) 9.5(108\dots)</math> (m) A1  Needs to be correct to 1 d.p.  FT from previous M1 for the correctly evaluated square root of 'their <math>90.4(564\dots)</math>' provided 'their answer' &gt; 'their <math>8.09(051\dots)</math>'</p>
<p>14.(b) <math>\sin^{-1}(1/9.5(108\dots))</math>  <math>= 6(0354\dots)^\circ</math></p>	<p>M2 A1</p>	<p>FT 'their <math>9.5(108\dots)</math>'  M1 for <math>\sin(\text{angle}) = 1/9.5(108\dots)</math>  Needs to be an answer that is &lt; <math>7.1</math>  Needs to be correct to 1 d.p.  Do not penalise premature rounding on FT if already penalised in (a)    <i>Alternative method:</i>  <math>\tan^{-1}(1/9.4(581\dots))</math> M2  <math>= 6.0(354\dots)^\circ</math> A1 OR  <math>\cos^{-1}(9.4(581\dots)/9.5(108\dots))</math> M2  <math>= 6.0(354\dots)^\circ</math> A1 OR    <i>Alternative method:</i>  B1 for 'Delyth's route is going up 1(m) in (travelling) <math>8.0(9051\dots)</math> m.' OR 'The gradient of Delyth's route is <math>(1/8.0(284\dots)) 0.12(455\dots)</math>'  B1 for 'loan's route is going up 1(m) in (travelling) <math>9.5(108\dots)</math> m.' OR 'The gradient of loan's route is <math>(1/9.4(581\dots)) 0.10(572\dots)</math>'  B1 for 'So loan's route is less steep.'  This B1 is dependent on previous B1B1 being awarded and provided loan's gradient is less steep than Delyth's  FT their values from (a)</p>

<p>4(a) DG = 3.2 (m) and DH = 3.4 (m)</p> $(GH)^2 = 3.2^2 + 3.4^2$ $(GH)^2 = 21.8 \text{ or } (GH =) \sqrt{21.8}$ <p>4.7(m) or 4.67(m) or 4.66(9...m) or 4.6(m)</p>	<p>B1</p> <p>M1</p> <p>M1</p> <p>A1</p>	<p>May be seen on the diagram</p> <p>FT 'their 3.2' and 'their 3.4' provided they are <math>\neq 4.8</math> and <math>\neq 6.8</math>(m)</p> <p>FT 'their 3.2' (DG) and 'their 3.4' (DH) including use of 4.8 and 6.8(m)</p> <p>Allow FT from M0, M1 including use of 4.8 and 6.8(m) to give 8.3(2...m) (i.e. B0, M0, M1, A1) FT from M1, M0 for the correctly evaluated square root of 'their 21.8' provided 'their answer' &gt; 3.4 (cm)</p>
<p>4(b) (Perimeter) 4.669... + 3.2 + 3.4</p> <p>Cost 12 × 3.50</p> <p>(£)42</p> <p>Appropriate for the perimeter 70(cm) or 73.(095....cm) or 74(cm) or 80 (cm) left over</p>	<p>M1</p> <p>M1</p> <p>A1</p> <p>B1</p>	<p>(11.2m, 11.269..m, 11.27m or 11.3m) FT 'their derived 4.669...' (from (a)) + 'their DG &lt;4.8' + 'their DH &lt;6.8', however if no response in (a) accept 'their GH' if clearly stated provided &gt;3.3 but &lt;8.4 (m)</p> <p>FT 'their derived perimeter' provided:</p> <ul style="list-style-type: none"> <li>the perimeter has been derived from the sum of 3 lengths, <b>AND</b></li> <li>rounded <b>up</b> correctly to a whole number</li> </ul> <p><b>Do not FT further for premature rounding of lengths to find 'their perimeter', no further marks</b> (Otherwise FT)</p> <p><b>Strict FT</b> 100 × ('their 12' – 'their <b>correctly evaluated</b> derived perimeter&lt;12'), which leads to left over bit <math>\geq 0</math> e.g. 74(cm) from a perimeter 11.26m Answer <b>must</b> be in cm Accept use of rounded or truncated answers for 'their derived perimeter'</p> <p><i>A fully correct FT for rounding lengths up prematurely, e.g. if 4.7m used: 4.7 is 5 strips, 3.4 and 3.2 is 4 strips each, gives 13 m, so 13 × £3.50 = (£)45.5(0) with 170(cm) left over, this is awarded M0, M1, A0, B0</i></p>

<p>17.</p> $\cos x = (3^2 + 7^2 - 6^2) / (2 \times 3 \times 7)$ <p style="text-align: center;">(x =) 58.4(1...°)</p> <p>Area of sector = 58.4(1...) / 360 × π × 7<sup>2</sup> ( Answer in the range: 24.9(595...cm<sup>2</sup>) to 25(cm<sup>2</sup>) )</p> <p>Area of triangle = ½ × 3 × 7 × sin 58.4(1...) ( Answer in the range: 8.9(4...cm<sup>2</sup>) to 8.94(4... cm<sup>2</sup>) or 9(cm<sup>2</sup>) )</p> <p>(Area of shaded region) answer in the range of 15.9(cm<sup>2</sup>) to 16.1(cm<sup>2</sup>)</p>	<p>S1</p> <p>M2 A1</p> <p>M1</p> <p>M1</p> <p>A2</p>	<p>For an attempt to subtract area of a triangle from the area of sector (This may even include an expression in terms of x).</p> <p>M1 for <math>6^2 = 3^2 + 7^2 - 2 \times 3 \times 7 \times \cos x</math> Allow 58°.</p> <p>FT 'their derived 58.4(1...°)'</p> <p>FT 'their derived 58.4(1...°)' M0 for use of a right-angled triangle. Unsupported 9 cm<sup>2</sup> gains M0.</p> <p>FT 'their derived 58.4(1...°)' provided previous M1, M1 awarded. Award A1 for sight of either: area of sector in the range 24.9(595...cm<sup>2</sup>) to 25(cm<sup>2</sup>) FT 'their derived 58.4(1...°)'</p> <p>OR area of triangle in the range 8.9(4...cm<sup>2</sup>) to 8.94(4... cm<sup>2</sup>) or 9(cm<sup>2</sup>) FT 'their derived 58.4(1...°)'</p> <p>This A1 is dependent on gaining the corresponding M1.</p> <p>NB Unsupported answer of 16(cm<sup>2</sup>) gains 0.</p>
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<p>14. <math>AB = (191/360) \times 2 \times \pi \times 3.1</math>  <math>= 10.3(\dots\text{cm})</math></p>	<p>M1 A1</p>	<p>Unsupported 30 or 30.1 gains no marks.  Sight of correct work to calculate major arc AB.  Accept an answer in the range 10.2(cm) to 10.4(cm).  Allow in terms of <math>\pi</math>, e.g. <math>\frac{5921}{1800}\pi</math>.  Mark final answer.  SC1 for 9.1(cm) to 9.2(cm), the minor arc AB.  Must be accompanied by <math>120/360 \times 2 \times \pi \times 3.1</math></p>
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14(a) $3\pi$	B1	
14(b) Sight of $\frac{120 \times 2 \times \pi \times 4.5}{360}$ OR $\frac{150 \times 2 \times \pi \times 3}{360}$	B1	Or equivalents
$\frac{120 \times 2 \times \pi \times 4.5}{360} + \frac{150 \times 2 \times \pi \times 3}{360}$	M1	Or equivalent
$= \frac{3\pi}{3} + \frac{5}{2}\pi$ OR $\frac{11\pi}{2}$ or $5.5\pi$	A1	May be implied in further working or final answer
(Length of belt =) $75 + \frac{17\pi}{2}$ or $75 + 8.5\pi$ or $\frac{150 + 17\pi}{2}$	B1	FT their answer to (a) and 'their $11\pi/2$ ' provided M1 awarded Needs to be in its simplest form  If no marks awarded, SC2 if $3\pi/2$ given in (a), leading to an answer of $75 + 17\pi/4$ or $75 + 4.25\pi$ SC1 if $3\pi/2$ given in (a), leading to an unsimplified version of $75 + 17\pi/4$
14(c) Use of $\frac{3}{4.5}$ or $\frac{4.5}{3}$ or equivalents with 2400	B1	e.g. ratio of 3 : 4.5 or 4.5 : 3 or equivalents B0 if $1.5 (4.5/3)$ comes from $3 + 1.5 = 4.5$
$2400 \times \frac{3}{4.5}$ or equivalent	M1	
= 1600 (revolutions)	A1	<i>Alternative method:</i> B1 for use of $6/4.5$ or $4.5/6$ with 1200 M1 for $1200 \times \frac{6}{4.5}$ or equivalent A1 for 1600 (revolutions)

<p>7.                    AOB = 148(°)</p> <p>Angle subtended by an arc at the centre of a circle is twice the angle subtended at the circumference.</p> $x = \frac{180 - 148}{2}$ $= 16$	<p>B1</p> <p>E1</p> <p>M1</p> <p>A1</p>	<p>May be seen on the diagram. Do not accept 148 unless unambiguously associated with angle AOB (stated, or on diagram, or used for M1).</p> <p>Dependent on <math>2 \times 74 (= 148)</math> seen. Accept any unambiguous wording. E0 for simply stating 'twice 74'.</p> <p>FT 'their derived or stated angle AOB'. NOT 74°. <math>x = 90 - 74</math> is B1E0M1 (E1 if a full and accurate explanation is given.)</p> <p>Unsupported (<math>x =</math>) 16 gains B1E0M1A1.</p>
<p>Organisation and Communication.</p> <p>Accuracy of writing.</p>	<p>OC1</p> <p>W1</p>	<p>For OC1, candidates will be expected to:</p> <ul style="list-style-type: none"> <li>• present their response in a structured way</li> <li>• explain to the reader what they are doing at each step of their response</li> <li>• lay out their explanation and working in a way that is clear and logical</li> </ul> <p>For W1, candidates will be expected to:</p> <ul style="list-style-type: none"> <li>• show all their working</li> <li>• make few, if any, errors in spelling, punctuation and grammar</li> <li>• use correct mathematical form in their working</li> <li>• use appropriate terminology, units, etc</li> </ul>



**WJEC GCSE MATHEMATICS**  
**SUMMER 2019 MARK SCHEME**

GCSE MATHEMATICS Unit 2 : Higher Tier	Mark	Comments
1.(a) $3n + 5$ or equivalent	B2	B1 for sight of $3n$ . B0 for $-3n$ Mark final answer.
1.(b) $3t = r + 8$ or $r + 8 = 3t$ or $-3t = -r - 8$ $t = \frac{r+8}{3}$ or $\frac{r+8}{3} = t$ or $t = \frac{-r-8}{-3}$	B1 B1	F.T. only from $3t = \pm r \pm 8$ , stated or implied. ( $3t = r + 8$ will have already gained the previous B1.) B1B0 for $-t = \frac{-r-8}{3}$ or equivalent. Mark final answer. <u>Note</u> Allow B1B0 for $t = (r + 8) \div 3$ with or without brackets. Allow B1B0 for $\frac{r+8}{3}$ ('t' missing)
1.(c) $6x + 4 = 46$ OR $3x + 2 = 23$  $6x = 42$ OR $3x = 21$  $(x =) 7$	B2  B1 B1	B1 for $(x + 5) + (2x - 3) + (x + 5) + (2x - 3) = 46$ or equivalent e.g. $(x + 5) + (2x - 3) = 23$  B1 FT collection of 'their terms' if of equivalent difficulty. (linear equation only.) B1 FT <u>only</u> from $ax = b$ . Allow a fraction from a FT value unless $x$ is a whole number. $(x =) 7$ gains all four marks. Each B mark implies all previous B marks. Mark final answer.
1.(c) <u>Alternative method</u> A trial showing correct values and understanding of perimeter. (e.g. $2(4 + 5) + 2(2 \times 4 - 3) = 28$ ) An <u>improved</u> trial.  $(x =) 7$	B1  B1 B2	Consistent use of $x$ AND correct evaluation.  B1 Dependent on first B1. If 1 <sup>st</sup> trial is using '7' award B1B1 followed by B1 if left embedded but B2 if shown as $x = 7$ . B2 B1 for an implied / embedded ' $x = 7$ ' but not shown as $x = 7$ . $(x =) 7$ gains all four marks. Mark final answer.

	or equivalent	
12. Values given for any <b>two</b> missing angles.	B1	(Check diagrams) Missing angle(s) is/are $32^\circ$ or $83^\circ$ and $65^\circ$ If all three angles are given, they must all be correct.
Explanation that the triangles are congruent due to angle, side, angle or ASA or equivalent.	E1	Or equivalent. No FT from incorrect angles. Dependent on at least one correct angle found.

<p>8.</p> <p>One correct evaluation <math>1 \leq x \leq 2</math>                  2 correct evaluations <math>1.55 \leq x \leq 1.75</math>,                  one <math>&lt; 0</math>, one <math>&gt; 0</math>.                  2 correct evaluations <math>1.55 \leq x \leq 1.65</math>,                  one <math>&lt; 0</math>, one <math>&gt; 0</math>.</p> <p style="text-align: center;"><math>x = 1.6</math></p>	<p>B1 B1 M1 A1</p>	<p><i>Correct evaluation regarded as enough to identify if 'too high' or 'too low'. If evaluations not seen accept 'too high' or 'too low'.</i></p> <p style="text-align: center;"><math>x</math>                      <math>2x^3 + x - 10</math> (or check <math>2x^3 + x = 10</math>)</p> <p>1                      -7                  1.1                  -6.238                  1.2                  -5.344                  1.3                  -4.306                  1.4                  -3.112                  1.45    - 2.452...                  1.5                  -1.75                  1.55    - 1.002...  <b>1.6                  -0.208                  1.65    0.634...</b>  <b>1.7                  1.526                  1.75    2.468...</b>                  1.8                  3.464                  (1.62 0.123...)                  1.9                  5.618                  (1.63 0.291...)                  2                      8                      (1.64 0.461...)</p>
<p>9.                  <math>85\% \equiv \frac{6154}{85}</math>  <math>\frac{6154 \times 100}{85}</math> OR <math>\frac{6154}{0.85}</math>  <span style="margin-left: 150px;"><math>= 7240</math></span></p>	<p>B1 M1 A1</p>	<p>Accept any indication.                  Implies the B1.</p>
<p>10.                  <math>x = 54^\circ</math>  <u>Opposite angles</u> (of a) <u>cyclic quad.</u> (add up to <math>180^\circ</math>).</p> <p style="text-align: center;"><math>y = 108^\circ</math>  <u>Angle at the centre</u> (is twice the angle at the circumference).</p>	<p>B1 E1  B1 E1</p>	<p>Dependent on an attempt at <math>180 - 126</math>.</p> <p>FT <math>2 \times</math> 'their 54' only if less than <math>360^\circ</math>                  Dependent on an attempt at <math>2 \times</math> 'their 54'.</p>
<p>11.                  Correct enlargement</p>	<p>B2</p>	<p>Otherwise B1 for 2 correct vertices within a triangle.                  OR for 3 correct vertices in the correct location not joined to form the triangle                  OR triangle of correct shape, size and orientation in incorrect position                  OR consistent correct use of an incorrect negative scale factor.</p>
<p>12(a).              <math>(9p + 1)(9p - 1)</math></p>	<p>B2</p>	<p>B1 for <math>(9p \dots 1)(9p \dots 1)</math></p>
<p>12(b).              <math>(7t - 2)(t + 3)</math></p>	<p>B2</p>	<p>B1 for <math>(7t \dots 2)(t \dots 3)</math></p>
<p>13.                  Sight of 297.5 AND 6.5  <math>297.5 \div 6.5</math>  <span style="margin-left: 150px;"><math>= 45.77(\text{km/h})</math></span></p>	<p>B1 M1  A1</p>	<p>Accept 6 hours 30 minutes, but not 6.3 hours.                  If other calculations shown, then the relevant calculation must be identified.                  Award M1 for their values provided <math>295 \leq d &lt; 300</math> AND <math>6 &lt; t \leq 7</math> (but not 6 hours 30 minutes).                  CAO. Correct answer must be clearly identified.</p>
<p>14.                  <math>\sin \text{BAD} = (2 \times 70) / (8 \times 19)</math> or equivalent</p> <p style="text-align: center;"><math>(\text{BAD} =) 67(.08\dots)^\circ</math></p> <p>(Area of sector ABD =) <math>67(.08\dots) / 360 \times \pi \times 8^2</math></p> <p>Accept answers in the range <math>37.4(\text{cm}^2)</math> to <math>37.5(\text{cm}^2)</math>                  OR <math>37(\text{cm}^2)</math></p>	<p>M2  A1  M1  A1</p>	<p>Allow any unambiguous indication of angle BAD.                  M1 for the <u>correct use</u> of the formula when <math>\sin \text{BAD}</math> is <u>not</u> the subject, for example: <math>70 = 1/2 \times 8 \times 19 \times \sin \text{BAD}</math>.</p> <p>Allow any answer that rounds to <math>67^\circ</math>.</p> <p>Accept <math>292.9(\dots) / 360 \times \pi \times 8^2</math> OR <math>293 / 360 \times \pi \times 8^2</math> for the area of the major sector ABD.                  FT their derived or stated value of angle BAD.</p> <p>Accept an answer in the range <math>163.5(\text{cm}^2)</math> to <math>163.7(\text{cm}^2)</math> OR <math>164(\text{cm}^2)</math> for the area of the major sector ABD.</p>

<p>11(a)(i). <math>\frac{x+1+x+2}{2} \times x (= 25)</math></p> <p><math>x^2 + x + x^2 + 2x = 50</math>  OR <math>x(2x + 3) = 50</math>  OR <math>\frac{2x^2+3x}{2} = 25</math>  OR <math>x^2 + 1.5x = 25</math></p> <p><math>2x^2 + 3x - 50 = 0</math></p>	<p>M1</p> <p>m1</p> <p>A1</p>	<p>Missing brackets in the expression <math>\frac{x(x+1+x+2)}{2}</math> may be implied later from correct working.</p> <p>Must be convincing.  If m1 awarded for <math>\frac{2x^2+3x}{2} = 25</math>, a further rearrangement, e.g. <math>2x^2 + 3x = 50</math>, must be seen before A1 is awarded.</p>
<p>11(a)(ii). <math>x = \frac{-(3) \pm \sqrt{(3)^2 - 4 \times 2 \times (-50)}}{2 \times 2}</math></p> <p><math>= \frac{-3 \pm \sqrt{409}}{4}</math></p> <p><math>x = 4.3(059 \dots), (x = -5.8(059 \dots))</math>  (AB=) 5.3(cm) AND (DC=) 6.3(cm)</p>	<p>M1</p> <p>A1</p> <p>A1</p> <p>B1</p>	<p>Maybe seen in a(i).  Allow one slip in substitution <b>for M1 only</b>, but must be correct formula.</p> <p>CAO.  Answers must be to 1 d.p.  FT 'their positive x' provided M1 awarded.</p>
<p>11.(b) <math>7^2 \times 36.8</math> OR <math>(7 \times \sqrt{36.8})^2</math>  <math>= 1803.2 \text{ (cm}^2\text{)}</math></p>	<p>M1</p> <p>A1</p>	<p>Allow 1803 (cm<sup>2</sup>)</p>

<p>12. <math>\frac{42}{360} \times 2 \times \pi \times 7</math></p> <p><math>= 5.1(\dots)</math> OR <math>\frac{49}{30}\pi</math></p> <p>(Perimeter =) <math>19.1(\dots\text{cm})</math> OR <math>14 + \frac{49}{30}\pi(\text{cm})</math></p>	<p>M1</p> <p>A1</p> <p>A1</p>	<p>Or equivalent. Allow 5 from correct working.</p> <p>Mark final answer. FT 'their 5.1(...cm)'. Allow 19 (cm) from correct working.</p>
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(y =) 2f(x)	B1	
17. For an attempt to subtract the area of a triangle from the area of square, with use of cosine rule and area of a triangle formula ( $\frac{1}{2}absinC$ ).	S1	
(Area of square or $CD^2 = 8^2 + 9^2 - 2 \times 8 \times 9 \times \cos 75^\circ$ $CD^2 = 107.7(30\dots)$ OR $CD = 10.37(9\dots\text{cm})$ OR $CD = 10.38(\dots\text{cm})$ OR $CD = \sqrt{107.7(30\dots)}$ Area of square = $107.7(30\dots\text{cm}^2)$	M1 A1	Allow ( $CD =$ ) $\sqrt{[8^2 + 9^2 - 2 \times 8 \times 9 \times \cos 75^\circ]}$ Allow $CD = 10.4$ (cm)
(Area of triangle =) $\frac{1}{2} \times 8 \times 9 \times \sin 75^\circ$ $= 34.77(\dots\text{cm}^2)$ OR $34.8(\text{cm}^2)$ OR $9\sqrt{6} + 9\sqrt{2}(\text{cm}^2)$	M1 A1	Allow an answer in the range $107.5(\text{cm}^2)$ to $108.2(\text{cm}^2)$ . May be implied in further working.
(Area of the shaded region =) answer in the range of $72.9$ (cm <sup>2</sup> ) to $73$ (cm <sup>2</sup> )	B1	CAO.

4.(a)	an expression	B1	
4.(b)	an equation	B1	
5.	(Mid-points) 2·5, (7·5), 12·5 and 17·5. $8 \times 2\cdot5 + (0 \times 7\cdot5) + 7 \times 12\cdot5 + 5 \times 17\cdot5$ $(20 + 0 + 87\cdot5 + 87\cdot5 = 195)$ $\div 20$ $= 9\cdot75$	B1 M1  m1 A1	Allow for sight of mid-points. F.T. 'their mid-points' including bounds, provided they fall within the classes (including lower and upper bounds and used consistently). C.A.O.
6.	( x = ) $\frac{360}{15}$ or $180 - \frac{(15-2) \times 180}{15}$ or equivalent $= 24(^{\circ})$ (BR = ) $8 \times \cos 24$ or $8 \times \sin (90 - 24)$ $= 7\cdot3(0\dots)(\text{cm})$ or $7\cdot31(\text{cm})$	M1  A1 M2  A1	May be seen in parts.  FT 'their stated value for x' ( $x < 90^{\circ}$ ) M1 for $\frac{BR}{8} = \cos 24$ or $\frac{BR}{8} = \sin (90 - 24)$ Accept equivalent of using sin rule (as $\sin 90 = 1$ ).  <u>Alternative method to find BR</u> A correct and complete method (using two trigonometric relationships and possibly Pythagoras's theorem) M2 $BR = 7\cdot3(0\dots)(\text{cm})$ or $7\cdot31(\text{cm})$ A1
7.	$2\cdot656 \times 10^6$	B2	B1 for a correct value but not in standard form. Mark final answer. B1 for sight of 2 656 000. SC1 for $2\cdot66 \times 10^6$ or $2\cdot7 \times 10^6$ or $2\cdot6 \times 10^6$ or $2\cdot65 \times 10^6$
8.	Sight of 24·5 AND 15·5 OR Sight of 23·5 AND 14·5  $2(24\cdot5 + 15\cdot5) - 2(23\cdot5 + 14\cdot5)$ or equivalent  $= 4(\text{cm})$	B1  M1  A1	Sight of (Greatest =) 80 <u>OR</u> (Least =) 76 implies B1  FT only for upper bounds of 24·4 AND 15·4 or 24·49 AND 15·49 (lower bounds must be 23·5 AND 14·5 else M0)  CAO If M0, award B1 and an SC1 for sight of (Greatest =) 80 <u>AND</u> (Least =) 76
	<u>Alternative method.</u> Difference between least and greatest length for each side = 1(cm) $4 \times 1$  $= 4(\text{cm})$	B1  M1  A1	  FT only for differences of 0·9 or 0·99  CAO
9.	Method to eliminate variable e.g. equal coefficients with <u>appropriate</u> addition or subtraction. First variable found, $x = 4$ or $y = -1$ . Substitute to find the 2 <sup>nd</sup> variable. Second variable found	M1  A1 m1 A1	No marks for trial and improvement. Allow 1 error in one term, not the term with equal coefficients.  C.A.O. F.T. their '1 <sup>st</sup> variable'.  Award no marks for unsupported correct answers.

<p>20.</p> $(x =) \frac{12}{\sin 46} \times \sin 34$ $(x =) 9.3(28\dots\text{cm}) \text{ OR } 9.32(\text{cm})$ <p>(Area of sector ACB=) <math>\frac{46}{360} \times \pi \times 9.3(28\dots)^2</math></p> $= 34.9(3\dots\text{cm}^2)$ <p>(Area of ACE=) <math>\frac{1}{2} \times 9.3(28\dots) \times 12 \times \sin(100)</math></p> $= 55.1(2\dots\text{cm}^2)$ <p>(Area of the shaded region BCE = <math>55.1\dots - 34.9\dots</math> )</p> $= 20.18(8\dots\text{cm}^2) \text{ OR } 20.2(\text{cm}^2)$		<p>A correct and complete method involving multiple trigonometric relationships leading to the correct answer may be seen at any stage to gain the method mark(s).</p> <p>M2 M1 for <math>\frac{x}{\sin 34} = \frac{12}{\sin 46}</math> or equivalent.</p> <p>A1</p> <p>M1 FT 'their derived 9.3(28\dots)'. A1 Answers in the range 34.7(cm<sup>2</sup>) to 35(cm<sup>2</sup>) or equivalent range on FT.</p> <p>M1 FT 'their derived 9.3(28\dots cm) A1 Answers in the range 54.95(cm<sup>2</sup>) to 55.13(cm<sup>2</sup>) or equivalent range on FT.</p> <p>B1 FT 'their 34.9(\dots\text{cm}^2)' and 'their 55.1(\dots\text{cm}^2)' provided previous M1, M1 (from area calculations) awarded AND 'area of the shaded region' &gt; 0. This answer must be derived from the subtraction of 'their areas'.</p>
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<p>8. <math>(x - 6)(x + 2)</math>  <math>(x =) 6</math> AND <math>(x =) -2</math></p>	<p>B2 B1</p>	<p>B1 for <math>(x \dots 6)(x \dots 2)</math>.                  Strict F.T. from their <u>brackets</u>.                  Penalise change of letter -1.                  Allow the following.                  B2 for <math>x - 6 (=0)</math> AND <math>x + 2 (=0)</math> (B1)  <math>(x =) 6</math> AND <math>(x =) -2</math> (B1)                   B1 for <math>x + 6 (=0)</math> AND <math>x - 2 (=0)</math> (B0)  <math>(x =) -6</math> AND <math>(x =) 2</math> (B1) FT                   B1 if only <math>(x =) 6</math> AND <math>(x =) -2</math> seen. (B1)                  Use of quadratic formula would only lead to this B1.                  Mark final answer.</p>								
<p>9. (Arc length =)  <math>\frac{212}{360} \times 2 \times \pi \times 7 \cdot 3 =</math>                  26.99 to 27.0143 (cm) or <math>\frac{3869\pi}{450}</math>                   (Perimeter = their arc length + <math>2 \times 7 \cdot 3</math>)                   = 42 or 41.6 (cm)</p>	<p>M1 A1 B1</p>	<p>Seen or implied.                   Accept 41.59 to 41.6143 (cm).                  FT 'their derived arc length' + 14.6, provided M1 awarded.</p>								
<p><u>Alternative version</u>   <math>\frac{212}{360} \times 2 \times \pi \times 7 \cdot 3 + 2 \times 7 \cdot 3 =</math>                  = 42 or 41.6 (cm)                  Organisation and Communication.                           Accuracy of writing.</p>	<p>M2 A1 OC1 W1</p>	<p>Accept 41.59 to 41.6143 (cm).                  For OC1, candidates will be expected to:</p> <ul style="list-style-type: none"> <li>• present their response in a structured way</li> <li>• explain to the reader what they are doing at each step of their response</li> <li>• lay out their explanation and working in a way that is clear and logical</li> <li>• write a conclusion that draws together their results and explains what their answer means</li> </ul> <p>For W1, candidates will be expected to:</p> <ul style="list-style-type: none"> <li>• show all their working</li> <li>• make few, if any, errors in spelling, punctuation and grammar</li> <li>• use correct mathematical form in their working</li> <li>• use appropriate terminology, units, etc</li> </ul>								
<p>10. (a)(i) <math>y \propto 1/\sqrt{x}</math> OR <math>y = k/\sqrt{x}</math>   <math>65 = k/\sqrt{51 \cdot 84}</math> OR <math>65 = k/7 \cdot 2</math> OR  <math>k = 65 \times \sqrt{51 \cdot 84}</math> OR <math>k = 65 \times 7 \cdot 2</math> OR <math>k = 468</math>   <math>(y =) 468/\sqrt{x}</math></p>	<p>B1 M1 A1</p>	<p>Allow <math>y \propto k/\sqrt{x}</math>                   M1 implies B1                  F.T. for B0 M1 from <math>y \propto 1/x^n</math> with <math>n &gt; 0</math> and <math>n \neq 1/2</math>                  No F.T. from direct proportion                   May be seen explicitly in part (ii).</p>								
<p>10. (a)(ii)</p> <table border="1" data-bbox="177 1659 619 1749"> <tr> <td>x</td> <td>51.84</td> <td>15.21</td> <td><b>36</b></td> </tr> <tr> <td>y</td> <td>65</td> <td><b>120</b></td> <td>78</td> </tr> </table>	x	51.84	15.21	<b>36</b>	y	65	<b>120</b>	78	<p>B2</p>	<p>Check working space (if table left blank).                  B1 for one correct value.                  F.T. for consistent use of 'their expression' for inverse proportion only, but not for <math>y = 1/x</math></p>
x	51.84	15.21	<b>36</b>							
y	65	<b>120</b>	78							
<p>10. (b) <math>c</math> is multiplied by 4</p>	<p>B1</p>									

<p>11. <math>\sin \text{BAD} = \frac{2 \times 112}{10 \times 27}</math> or equivalent</p> <p>(BAD=) <math>56(.06\dots^\circ)</math></p> <p>(Area of shaded region=) <math>112 - \frac{56(.06\dots)}{360} \times \pi \times 10^2</math></p> <p>(Area of shaded region =) <math>63(.077\dots \text{cm}^2)</math> or answers in the range: 63 to <math>63.2 \text{ (cm}^2)</math></p>	<p>M2</p> <p>A1</p> <p>M2</p> <p>A1</p>	<p>calculation.</p> <p>M1 for the <u>correct use</u> of the formula when <math>\sin \text{BAD}</math> is <u>not</u> the subject e.g. <math>112 = \frac{1}{2} \times 10 \times 27 \times \sin \text{BAD}</math>.</p> <p>Accept <math>56.1^\circ</math>. Allow correct angles given in radians (0.9784..) or gradians (62.2896....)</p> <p>F.T. their derived or stated value of angle BAD. M1 for <math>\frac{56(.06\dots)}{360} \times \pi \times 10^2 (=48.92 \text{ cm}^2)</math></p>
<p><u>Alternative method for the first 3 marks</u></p> <p>Correct use of a two-step method.</p> <p>(BAD=) <math>56(.06\dots^\circ)</math></p>	<p>M2</p> <p>A1</p>	<p><u>Example</u> (Perpendicular height of triangle=) <math>112 \times 2 \div 27 = 8.2(96\dots)</math> or <math>8.3</math> (BAD=) <math>\sin^{-1}[8.2(96\dots) \div 10]</math></p> <p>Allow correct angles given in radians (0.9784...) or gradians (62.2896....)</p>

<p>3.(a) Valid written explanation referring to negative values <b>representing sides</b>                  e.g. “<math>(4 \times 2 - 10 = -2)</math> you can't have a negative value for a side”                  “<math>x</math> must be greater than 2.5 to have a positive value for the side”</p>	<p>E1</p>	<p>Allow “you can't have a negative length”.</p> <p>Do not allow</p> <ul style="list-style-type: none"> <li>• calculations only</li> <li>• “it can't be negative”</li> <li>• “the value can't be negative”.</li> </ul>
<p>3.(b)</p> <p style="text-align: center;"><math>14x - 4 - 2 \times (4x - 10)</math> OR  <math>14x - 4 - 8x + 20</math> or equivalent</p> <p style="text-align: center;">(sum of both lengths=)                      <math>6x + 16</math></p> <p style="text-align: center;">(length=)                                      <math>3x + 8</math></p>	<p>M2</p> <p>A1</p> <p>B1</p>	<p>May be seen on diagram.                  Award M1 for intention for a method                  e.g. <math>4x - 10 + 4x - 10 + ? = 14x - 4</math>                  e.g. <math>14x - 4 = ? + 2 \times (4x - 10)</math>                  e.g. incorrect use of brackets but a clear attempt at the correct calculation is seen: <math>14x - 4 - 8x - 20</math>.</p> <p>FT from M1: <math>14x - 4 - \text{'their } 2 \times [4x - 10]\text{'}</math> or equivalent, provided ‘their <math>8x - 20</math>’ can be expressed in the form <math>ax + b</math>, with <math>a \&amp; b \neq 0</math>.                  Note: <math>14x - 4 - 8x - 20 = 6x - 24</math> is awarded M1A1.</p> <p>May be seen on diagram.                  Mark final answer.                  FT ‘their <math>6x + 16</math>’ <math>\div 2</math>, provided in the form <math>ax + b</math>, with <math>a \&amp; b \neq 0</math>.</p> <p>Unsupported <math>3x + 8</math> is awarded M2 A1 B1.</p> <p>If no marks awarded, award SC1 for a final answer of:</p> <ul style="list-style-type: none"> <li>• <math>3x + c</math> (<math>c \neq 8</math>)</li> <li>• <math>kx + 8</math> (<math>k \neq 3</math> and positive).</li> </ul>
<p><u>Alternative method:</u></p> <p style="text-align: center;"><i>Sight of an appropriate</i> <math>7x - 2</math>  <math>7x - 2 - 4x + 10</math></p> <p style="text-align: center;">(length=)                                      <math>3x + 8</math></p>	<p>B1</p> <p>M2</p> <p>A1</p>	<p>May be seen on diagram.</p> <p>Award M1 for intention for a method                  e.g. <math>4x - 10 + ? = 7x - 2</math>  <math>[14x - 4] \div 2 - [4x - 10]</math> or equivalent                  e.g. incorrect use of brackets but a clear attempt at the correct calculation is seen</p> <p>May be seen on diagram.                  Mark final answer.                  Allow FT from M1.</p> <p>Unsupported <math>3x + 8</math> is awarded B1 M2 A1.</p> <p>If no marks awarded, award SC1 for a final answer of:</p> <ul style="list-style-type: none"> <li>• <math>3x + c</math> (<math>c \neq 8</math>)</li> <li>• <math>kx + 8</math> (<math>k \neq 3</math> and positive).</li> </ul>

<p>4. <u>(Length of AB)</u>  <math>18^2 = AB^2 + 10^2</math> OR <math>(AB^2 =) 18^2 - 10^2</math>  or equivalent  <math>(AB^2 =) 224</math>  <math>(AB =) 14.9(66\dots)</math> or 15 or <math>4\sqrt{14}</math> or <math>\sqrt{224}</math> (cm)</p> <p>(Area of the circle =) <math>\pi \times 9^2</math></p> <p>(Area of the triangle =)  <math>\frac{1}{2} \times 10 \times 14.9(66\dots)</math> or equivalent</p> <p>254.4(69\dots) (cm<sup>2</sup>) or <math>81\pi</math>  <b>AND</b>  <math>74.8(33\dots)</math> or <math>20\sqrt{14}</math> (cm<sup>2</sup>)</p> <p>(Area of the shaded region =  <math>254.4(69) - 74.8(33\dots) =</math>  179 to 180 (cm<sup>2</sup>)</p>	<p>M1 A1 A1 M1 M1 A1 B1</p>	<p>note: <math>(AB^2 =) 324 - 100</math></p> <p>FT 'their 224' provided M1 gained for M1A0A1.</p> <p><i>Alternative method to find AB</i>  A correct and complete method that would lead to a correct answer (using trigonometric relationships).  M2  <math>(AB =) 14.9(66\dots)</math> or 15 or <math>4\sqrt{14}</math> or <math>\sqrt{224}</math> (cm) A1</p> <p>Award M1 for sight of 75 or <math>20\sqrt{14}</math>.  FT <math>\frac{1}{2} \times 10 \times</math> 'their AB', provided not 18 or 10.  Accept any valid method that leads to a correct answer.</p> <p>An answer between 254.3 and 254.51 (cm<sup>2</sup>).  Allow 254.  Allow 75.</p> <p>Allow rounded or truncated answers.  FT 'their area of a circle' – 'their triangle' (not 'their AB') provided at least one area M1 awarded previously.</p>
<p><u>Alternative method to first calculate angle BCA and then use <math>\frac{1}{2}ab\sin C</math> to calculate the area of the triangle</u></p> <p><math>(BCA =) \cos^{-1} \frac{10}{18}</math></p> <p>Correct evaluation in the range 56.2 to 56.3</p> <p>(Area of the triangle =)  <math>\frac{1}{2} \times 10 \times 18 \times \sin(56.251\dots)</math></p> <p>(Area of the circle =) <math>\pi \times 9^2</math></p> <p>254.4(69\dots) (cm<sup>2</sup>) or <math>81\pi</math>  <b>AND</b>  <math>74.8(33\dots)</math> or <math>20\sqrt{14}</math> (cm<sup>2</sup>)</p> <p>(Area of the shaded region =  <math>254.4(69) - 74.8(33\dots) =</math>  179 to 180 (cm<sup>2</sup>)</p>	<p>M2 A1 M1 M1 A1 B1</p>	<p>M1 for <math>\cos BCA = \frac{10}{18}</math> (= 0.555\dots)</p> <p><b>Note:</b> An alternative correct use of a 'two-step' method that would lead to the correct answer for BCA (e.g. finding angle BAC first) is M2.  A partial method is M0.</p> <p>Allow 56 from correct working.  Note: <math>\cos BCA = 0.55</math>, <math>BCA = 56.632\dots</math> OR  <math>\cos BCA = 0.56</math>, <math>BCA = 55.944\dots</math> is awarded M2A0.</p> <p>FT 'their BCA' if previous M1 awarded.</p> <p>An answer between 254.3 and 254.51 (cm<sup>2</sup>).  Allow 254.  Allow 75.</p> <p>Allow rounded or truncated answers.  FT 'their area of a circle' – 'their triangle' provided at least one area M1 awarded previously.</p>



<p>9.</p> $POQ = 180 - (2 \times 38)$ $104 (^\circ)$ $x = 52 (^\circ)$ <p>For two valid angle properties appropriately stated with at least one circle property (e.g. two radii make an <u>isosceles triangle</u> AND <u>angle subtended by an arc at the centre</u> of a circle is <u>twice the angle subtended at the circumference</u>)</p>	<p>M1 A1 B1</p> <p>E1</p>	<p>Check diagram for answers.</p> <p>Award M1A1 for sight of 104. FT 'their 104' ÷ 2.</p> <p>Award E1 for any one correct appropriate angle property AND any one appropriate correct circle property associated with correct workings. ISW any other incorrect properties.</p> <p>Allow</p> <ul style="list-style-type: none"> <li>• "the angles in a triangle (add to 180°)" for the 'angle' property</li> <li>• "angle at the centre (theorem)"</li> <li>• "equal radii" for isosceles.</li> </ul>
<p>9. <u>Alternative method – angles in a semi-circle</u> Extending the line (PO or QO) to create a right-angle triangle</p> $180 - 90 - 38$ $x = 52 (^\circ)$ <p>For two valid angle properties appropriately stated with at least one circle property (e.g. the angle subtended at the circumference by a semicircle is a right angle AND that angles in the same segment are equal)</p>	<p>S1</p> <p>M1 A1 E1</p>	<p>Shown on diagram</p> <p>M1 implies S1</p>

20.	$(x^2 \text{ or } BC^2 =) 19^2 + 29^2 - 2 \times 19 \times 29 \times \cos 36^\circ$ $(x \text{ or } BC =) 17.6(199\dots\text{cm})$	M1 A2	Penalise premature approximation, PA -1, once only. A1 for $(x^2 \text{ or } BC^2 =) 310.4(6\dots)$ OR $x = \sqrt{310.4(6\dots)}$ Award A2 if $x = \sqrt{310.4(6\dots)}$ is used correctly in subsequent work, but only A1 if an incorrect evaluation is used.
OR	$(\sin BCD =) \frac{19 \times \sin 36^\circ}{17.6(199\dots)}$ $(\cos BCD =) \frac{17.6(199\dots)^2 + 29^2 - 19^2}{2 \times 17.6(199\dots) \times 29}$ $(BCD =) 39.3(3\dots)^\circ$	M2	FT 'their derived 17.6(199...)' . M1 for $\frac{\sin BCD}{19} = \frac{\sin 36^\circ}{17.6(199\dots)}$ or equivalent OR M1 for $19^2 = 17.6(199\dots)^2 + 29^2 - 2 \times 17.6(199\dots) \times 29 \times \cos BCD$
	$(\text{Area of sector} =) \frac{39.3(3\dots)}{360} \times \pi \times 17.6(199\dots)^2$ Accept answers in the range $106(\text{cm}^2) \text{ to } 107(\text{cm}^2)$	M1  A1	FT for possible M1 A1, provided M1 M2 or M1 M1 previously awarded.  Must be from correct working.

<p>8.</p> $\frac{\pi \times r^2}{2} = 77 \text{ or equivalent}$ $r^2 = 49(\cdot 0\dots) \text{ or } r^2 = \frac{154}{\pi}$ $r = 7(\cdot 0\dots)$ <p>(Area of trapezium = ) <math>\frac{2 \times 7(\cdot 0\dots) + 22}{2} \times 7(\cdot 0\dots)</math> or equivalent</p> $= 126 \cdot 0(\dots)(\text{cm}^2)$	<p>M1</p> <p>m1</p> <p>A1</p> <p>M1</p> <p>A1</p>	<p>Check diagram for answers.</p> <p>Sight of <math>49(\cdot 0\dots)</math> implies M1m1.</p> <p>FT 'their <math>r^2</math>', provided M1 awarded. 7 must not be from incorrect working.</p> <p>FT 'their derived or stated <math>r</math>'.</p> <p>Accept <math>126 \cdot 1</math> or <math>126 \text{ (cm}^2\text{)}</math> Mark final answer.</p>
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<p>10.(a) (Reflex angle D = )  <math>180 + 360/5</math> OR <math>360 - 3 \times 180/5</math>  <math>= 252(^{\circ})</math>                    (Arc length CE = ) <math>252/360 \times \pi \times 2 \times 11</math>  <math>48.3(\dots)</math> OR <math>48.4</math> OR <math>77\pi/5</math> OR <math>15\frac{2}{5}\pi</math> OR <math>15.4\pi(\text{cm})</math>                  o.e.</p>	<p>M1 A1 M1 A1</p>	<p>Or any other complete method. May be seen in stages.                  Award for sight of <math>252(^{\circ})</math> if not contradicted by further incorrect work.                  FT for M1 for 'their derived angle'.                  ISW                  Accept <math>48(\text{cm})</math> from correct working.  <math>12089/250</math> from using <math>3 \cdot 14</math>                  Allow a FT for this mark provided the angle used is <math>&gt;180^{\circ}</math>.                  If no marks award SC1 for sight of <math>108(^{\circ})</math> OR <math>72(^{\circ})</math></p>
<p>Organisation and Communication                                Accuracy of writing</p>	<p>OC1                                W1</p>	<p>For OC1, candidates will be expected to:</p> <ul style="list-style-type: none"> <li>• present their response in a structured way</li> <li>• explain to the reader what they are doing at each step of their response</li> <li>• lay out their explanation and working in a way that is clear and logical</li> <li>• write a conclusion that draws together their results and explains what their answer means</li> </ul> <p>For W1, candidates will be expected to:</p> <ul style="list-style-type: none"> <li>• show all their working</li> <li>• make few, if any, errors in spelling, punctuation and grammar</li> <li>• use correct mathematical form in their working</li> <li>• use appropriate terminology, units, etc.</li> </ul>
<p>10.(b) <math>\left(\frac{671}{11}\right)^2</math> (= <math>450241/121</math>) OR <math>61^2</math>  <math>= 3721</math></p>	<p>M1 A1</p>	<p>Answer in the sentence takes precedence.                  If no marks, allow SC1 for <math>3721/25</math> OR <math>148\frac{21}{25}</math> OR <math>148.84</math> (from <math>3721/25</math>)</p>

4(a)(i) $440 \times 48 \div 2.2$  9600 (kg)	M1  A1	May be seen in stages  Mark final answer Allow answers in the inclusive range 9588 to 9601 from premature approximation Answer space takes precedence
4(a)(ii) 230 000 000 000	B1	
4(b)  (Area) $2.47 \times 40000 \div 10000$ or equivalent 9.88 (acres)  (Density of trees) $615 \div 9.88$ 62(.2...trees per acre) (>60)	M1 A1  m1 A1	<b>Throughout, if 4 marks are awarded, penalise -1 if conclusion 'Yes' is not indicated</b> <b>On FT the conclusion may be different to 'Yes'</b>  May be implied in further working Allow 9.8 (acres), 9.9 (acres) or 10 (acres)  Depends on M1 m1 previously awarded
4(b) <u>Alternative method 1</u> (Area) $2.47 \times 40000 \div 10000$ or equivalent 9.88 (acres)  (Maximum number of trees) $9.88 \times 60$ 592(.8) (trees) or 593 (trees) (< 615)	M1 A1  m1 A1	May be implied in further working Allow 9.8 (acres), 9.9 (acres) or 10 (acres)  Depends on M1 m1 previously awarded Allow suitable rounding, e.g. 590 or 600
4(b) <u>Alternative method 2</u> (Area) $2.47 \times 40000 \div 10000$ or equivalent 9.88 (acres)  (Minimum area) $615 \div 60$ 10.25 (acres) (> 9.88)	M1 A1  M1 A1	May be implied in further working Allow 9.8 (acres), 9.9 (acres) or 10 (acres)  Do not allow embedded in further working Allow rounded to 10 (acres) provided 'their area' (9.88m <sup>2</sup> ) has not been rounded to 10
4(b) <u>Alternative method 3</u> (Minimum area) $615 \div 60$  10.25 (acres)  (Convert to m <sup>2</sup> ) $10000 \times 10.25 \div 2.47$ 41 497(.97 m <sup>2</sup> ) or 41 498(m <sup>2</sup> ) (> 40 000)	M1 A1  m1 A1	May be implied in further working Allow 10 (acres)  Depends on M1 m1 previously awarded Accept suitable rounding, e.g. 41 000 or 41 500
4(b) <u>Alternative method 4</u> (Trees in 2.47 acres) $615 \div (40000 \div 10000)$ or equivalent 153.75 (trees)  (Density of trees) $153.75 \div 2.47$ 62(.2...trees per acre) (> 60)	M1 A1  m1 A1	May be implied in further working Allow 153, 153.8 or 154 (trees)  Depends on M1 m1 previously awarded
4(b) <u>Alternative method 5</u> (Forest area per tree) $40000 \div 615$ 65(.0406.. m <sup>2</sup> )  (Fire risk, area per tree) $10000 \div (60 \times 2.47)$ 67(.476...m <sup>2</sup> ) (> 65)	M1 A1  M1 A1	Do not allow embedded in further working

<p>4(c)(i) (Height of the tree =) <math>21 \times \tan 39</math></p> <p style="text-align: right;">17.(.... m)</p>	<p>M2</p> <p>A1</p>	<p>OR <i>alternative full method</i></p> <p>M1 for <math>\tan 39 = \frac{\text{height of tree}}{21}</math></p> <p>CAO</p>
<p>4(c)(i) <u>Alternative method 1</u></p> <p>Hypotenuse = <math>21/\cos 39</math> (= 27.02...)</p> <p>AND Height = <math>\sqrt{(27.02)^2 - 21^2}</math></p> <p style="text-align: right;">16.9(7...) (m) to 17.(0.m)</p>	<p>M2</p> <p>A1</p>	<p>M1 for Hypotenuse = <math>21/\cos 39</math> (= 27.02...)</p> <p>AND Height<sup>2</sup> = <math>27.02^2 - 21^2</math></p> <p>CAO</p>
<p>4(c)(i) <u>Alternative method 2</u></p> <p>(Angle of elevation) <math>\tan^{-1} \frac{17}{21}</math></p> <p style="text-align: right;">38.9(9...°) or 39(°)</p>	<p>M2</p> <p>A1</p>	<p>M1 <math>\tan</math> (elevation) = <math>\frac{17}{21}</math></p> <p>CAO</p>
<p>4(c)(i) <u>Alternative method 3</u></p> <p>(Horizontal distance) <math>\frac{17}{\tan 39}</math></p> <p style="text-align: right;">20.9(98...m) or 21m</p>	<p>M2</p> <p>A1</p>	<p>M1 for <math>\tan 39 = \frac{17}{\text{distance}}</math></p> <p>CAO</p>
<p>4(c)(ii) diameter = <math>\frac{1.75}{\pi}</math> or (radius) = <math>\frac{1.75}{2 \times \pi}</math></p> <p>(Area of cross section =) <math>\pi \times (1.75 \div 2\pi)^2</math></p> <p style="text-align: right;">× 17 ÷ 2</p> <p>(Volume) answer in the range 2.07 (m<sup>3</sup>) to 2.15 (m<sup>3</sup>)</p>	<p>M2</p> <p>M1</p> <p>m1</p> <p>A1</p>	<p>M1 for any one of the following:</p> <ul style="list-style-type: none"> <li>• <math>1.75 = \pi \times \text{diameter}</math></li> <li>• <math>1.75 = 2 \times \pi \times \text{radius}</math></li> </ul> <p>(Note: radius = <math>\frac{7}{8\pi}</math> m, radius ≈ 0.28m)</p> <p>FT for 'their derived radius' provided it is from a calculation involving the use of <math>\pi</math></p> <p>(Note: area of cross section = <math>\frac{49}{64\pi}</math> m<sup>2</sup> area of cross section ≈ 0.24 m<sup>2</sup>)</p> <p>FT provided previous M1 awarded</p> <p>CAO, accept an answer of 2 (m<sup>3</sup>) from correct working without sight of premature approximation leading to an answer outside the range</p>

8(a) $\frac{360 - 15 \times \pi \times 60}{360} (+60)$  $= 241 \text{ (mm)}$	M1  A2	A1 for any one of the following: <ul style="list-style-type: none"><li>• answer of 240.5(5) to 240.7</li><li>• answer of <math>\frac{115\pi}{2} + 60</math> or <math>57.5\pi + 60</math></li><li>• sight of (180.5(5) to 180.7) + 'their 60' correctly rounded to the nearest mm</li><li>• sight of 181</li></ul>
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<p>8(c) Statements required:</p> <ul style="list-style-type: none"> <li>• Number the parts from (0000)1 to 20000</li> <li>• Consider successive 5-digit numbers</li> <li>• Use numbers in the range e.g. Use numbers from (0000)1 to 20000 or Do not use 0000 or numbers &gt; 20000</li> <li>• Ignore repeats</li> </ul> <p>(Working in rows would give parts) (0)1325, 18266, <del>(0)1325</del>, (0)5929, 10429, (0)2891 OR</p> <p>(Working in columns would give parts) (0)5929, (0)1325, 10429, <del>(0)1325</del>, (0)2891, 18266</p>	<p>E2</p> <p>B1</p>	<p>All 4 needed for E2 E1 for any 2 or 3 correct statements</p> <p>Allow an equivalent numbering system e.g. (0000)0 to 19999 Their numbering system can be implied by the range of numbers they state they will choose from</p> <p>Allow the 2<sup>nd</sup> statement to be implied by their numbering of the parts (from 00001) AND their use of 5-digit numbers in their answer OR 5-digit numbers used in their answer and e.g. 01325 seen</p> <p>Do not allow 'Use numbers less than 20000' if they have numbered the parts from 00001 to 20000</p> <p>ISW. Part numbers can be given in any order</p>
<p><u>8(c) Alternative method:</u> Statements required:</p> <ul style="list-style-type: none"> <li>• Number the parts from (0000)1 to 20000</li> <li>• Consider successive 5-digit numbers</li> <li>• Divide each number by 20000 and use the remainder to choose a part</li> <li>• If the 5-digit number is 00000, then part 20000 is chosen, and ignore repeats.</li> </ul> <p>(Working in rows would give parts) (0)6923, (0)1325, 18552, <del>(0)6923</del>, (0)8925, 12712 OR</p> <p>(Working in columns would give parts) (0)6923, (0)8925, 15775, (0)5929, <del>(0)8925</del>, (0)1325</p>	<p>E2</p> <p>B1</p>	<p>All 4 needed for E2 E1 for any 2 or 3 correct statements</p> <p>Allow an equivalent numbering system e.g. (0000)0 to 19999 Their numbering system can be implied by the range of numbers they state they will choose from</p> <p>Allow the 2<sup>nd</sup> statement to be implied by their numbering of the parts (from 00001) AND their use of 5-digit numbers in their answer OR 5-digit numbers used in their answer and e.g. 06923 seen</p> <p>If (0000)0 to 19999 used, when the remainder is 0, part (0000)0 is selected</p> <p>ISW</p>



Mark	Mark	Comments
10.		
$\frac{(\text{reflex})\widehat{AOB}}{360} \times \pi \times 6^2 (= \frac{132\pi}{5} = 26 \cdot 4\pi)$ or equivalent	M1	Area of major sector.
$(360 - x \text{ OR reflex } \widehat{AOB}) \frac{132\pi \times 360}{5 \times \pi \times 6^2} (= 264)$	A1	Allow $\frac{x}{360} \times \pi \times 6^2 (= \frac{132\pi}{5})$ .
$x (= 360 - 264) = 96(^{\circ})$	A1	From A0, FT 360 – 'their 264', provided M1 awarded. An unsupported answer of 96(°) is awarded M1A1A1.
10. <u>Alternative method:</u> Area of minor sector = $\pi \times 6^2 - \frac{132\pi}{5} (= \frac{48\pi}{5} = 9 \cdot 6\pi)$	B1	Area of minor sector.
$\frac{x}{360} \times \pi \times 6^2 = \frac{48\pi}{5}$ or equivalent	M1	FT 'their derived' $\frac{48\pi}{5}$ .
$x = 96(^{\circ})$	A1	

	2U or equivalent	A1	CAO.										
9.(a)	125°	B1											
9.(b)	(Obtuse $\hat{BOD} =$ ) 110(°)	B1	<p>May be seen on the diagram.</p> <p>FT <math>360 - 2 \times</math> 'their value of <math>x</math> in part (a)'.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Value of <math>x</math> in part (a)</th> <th><math>\hat{BOD}</math></th> </tr> </thead> <tbody> <tr> <td>55°</td> <td>250(°)</td> </tr> <tr> <td>70°</td> <td>220(°)</td> </tr> <tr> <td>110°</td> <td>140(°)</td> </tr> <tr> <td>135°</td> <td>90(°)</td> </tr> </tbody> </table>	Value of $x$ in part (a)	$\hat{BOD}$	55°	250(°)	70°	220(°)	110°	140(°)	135°	90(°)
Value of $x$ in part (a)	$\hat{BOD}$												
55°	250(°)												
70°	220(°)												
110°	140(°)												
135°	90(°)												
(y = )	$\frac{180 - 110}{2}$ or equivalent	M1	FT $\frac{180 - \text{'their 110'}}{2}$ (may be stated or derived, provided 'their 110°' is not 55° and <180°).										
	35(°)	A1											

<p>9(a)(i) Sight of <math>\frac{150 \times 2 \times \pi \times 3}{360}</math> OR <math>\frac{300 \times 2 \times \pi \times 3}{360}</math>  <math>(= 2.5\pi)</math> <math>(= 5\pi)</math></p> <p>(Length of wire =)  <math>(2 \times) \frac{150 \times 2 \times \pi \times 3}{360} + (2 \times) 24 + 38</math> or equivalent  <math>= 5\pi + 86</math> (cm)</p>	<p>B1</p> <p>M1</p> <p>A2</p>	<p>Or equivalents</p> <p>Mark final answer</p> <p>A1 for sight of any one of the following:</p> <ul style="list-style-type: none"> <li><math>\frac{1800\pi + 86}{360}</math> or equivalent</li> <li><math>5\pi + \dots</math></li> <li><math>2.5\pi + \dots</math> or <math>5\pi/2 + \dots</math> provided an attempt has been made to add the 3 straight pieces</li> </ul>
<p>9(a)(ii) e.g. <math>10x = 1.333\dots</math>, <math>100x = 13.333\dots</math> AND an attempt to subtract both sides  <math>= \frac{12}{90}</math> or <math>\frac{132}{990}</math> or <math>\frac{1332}{9990}</math> or equivalent  <math>= \frac{2}{15}</math></p>	<p>M1</p> <p>A1</p> <p>A1</p>	<p>Allow A1 for e.g. 1.2/9</p> <p>FT from M1A0 provided of equivalent difficulty</p>
<p>9(a)(ii) <i>Alternative method:</i>  <math>\frac{1}{10} + \frac{3}{90}</math> or equivalent  <math>= \frac{12}{90}</math> or equivalent  <math>= \frac{2}{15}</math></p>	<p>M1</p> <p>A1</p> <p>A1</p>	<p>FT from M1A0 provided of equivalent difficulty</p>
<p>9(b) Statements required:</p> <ul style="list-style-type: none"> <li>Number the hangers from (0)1 to 80</li> <li>Consider successive 2-digit numbers</li> <li>Do not use numbers outside the range e.g. Do not use 00 and 81 – 99, OR Use the numbers (0)1 to 80</li> <li>Ignore repeats</li> </ul> <p>(Clothes hangers chosen =)  29, (0)7, (0)1, 30, 55, 79, 26, <del>30</del>, 12</p>	<p>E2</p> <p>B1</p>	<p>All 4 needed for E2  E1 for any 2 or 3 correct statements</p> <p>Allow an equivalent numbering system e.g. (0)0 to 79  Their numbering system can be implied by the range of numbers they state they will choose from</p> <p>Allow the 2<sup>nd</sup> statement to be implied by their numbering of the hangers (from 01) AND their use of 2-digit numbers in their answer  OR  2-digit numbers used in their answer with 07 and 01 seen</p> <p>Do not allow 'Use numbers less than 81' if they have numbered the hangers from 01 to 80, without stating that 00 will not be used</p> <p>ISW  Answer space takes precedence</p>
<p>9(c)  (Scale factor =) <math>\sqrt{1.44}</math> or 1.2</p> <p>(Height of larger hanger =) <math>\sqrt{1.44} \times 9</math> or <math>1.2 \times 9</math>  <math>= 10.8</math> (cm)</p>	<p>B1</p> <p>M1</p> <p>A1</p>	<p>FT 'their <math>\sqrt{1.44}</math>'  CAO</p>