



# Plane Geometry

*www.Q8Maths.com*

1	<p>9 (a) (i) Similar</p> <p>(ii) 4.5</p> <p>(iii) 13.5 cao</p> <p>(iv) <math>180 - x - y</math> oe <math>180 - x</math> oe</p> <p>(b) (i) 96</p> <p>(ii) 48 ft</p> <p>(iii) 97 ft</p> <p>(iv) 35</p> <p>(c) <math>20n = 360</math> oe or <math>\frac{180(n-2)}{n} = 160</math> oe or <math>180(n-2) = 8 \times 360</math> oe or <math>8\left(\frac{360}{n}\right) = 180 - \frac{360}{n}</math> 18 www 3</p>		<p>1</p> <p>2</p> <p>2</p> <p>B1 B1</p> <p>1</p> <p>1ft</p> <p>1ft</p> <p>1</p> <p>M2</p> <p>A1</p>	<p>Allow enlargement</p> <p>M1 for <math>\frac{AX}{3} = \frac{9}{6}</math> oe</p> <p>M1 for <math>\left(\frac{3}{2}\right)^2</math> or <math>\left(\frac{2}{3}\right)^2</math> oe e.g. using base and height but other methods must be complete</p> <p>ft 0.5 their (b)(i)</p> <p>ft 145 – their (b)(ii)</p> <p>M1 for <math>9e = 180</math> oe allow diagram to show this if reasonably clear</p> <p>or M1 for <math>8 \times 360</math> or <math>\frac{8 \times 360}{n}</math></p>
2	<p>5 (a) (i) Similar</p> <p>(ii) 2.7</p> <p>(iii) 3.15</p> <p>(b) (i) 29</p> <p>(ii) 61 ft</p> <p>(iii) 61 ft</p> <p>(iv) 119 ft</p> <p>(c) (i) 20</p> <p>(ii) 110</p>		<p>1</p> <p>2</p> <p>2</p> <p>1</p> <p>1ft</p> <p>1ft</p> <p>1ft</p> <p>1</p> <p>3</p>	<p>Accept enlargement</p> <p>M1 for <math>\frac{PQ}{3.6} = \frac{3}{4}</math> oe</p> <p>M1 for <math>\left(\frac{3}{4}\right)^2</math> or <math>\left(\frac{4}{3}\right)^2</math> o.e seen</p> <p>If <math>\frac{1}{2}ab \sin C</math> used or base and height used then must be full method for M1</p> <p>ft 90 – their (i) if (i) is acute</p> <p>ft their (ii) if their (ii) is acute, but can recover</p> <p>ft 180 – their (iii)</p> <p>M1 for adding 6 angles going up 4 each time and</p> <p>M1 (indep) for 720 seen and not spoiled (<math>6A + 60 = 720</math> o.e. scores M2)</p>

3	7	<p>(a) <math>w = 59</math> (angle in) isosceles (triangle)</p> <p><math>x = 31</math> (angle in) semicircle (= 90) oe</p> <p><math>y = 62</math> (angles in) same segment or (on) same arc (are =)</p> <p><math>z = 28</math> (angles in) triangle (= 180)</p> <p>(b) (i) <math>\begin{pmatrix} 2 \\ 3 \end{pmatrix}</math></p> <p>(ii) <math>\begin{pmatrix} -2 \\ 4 \end{pmatrix}</math></p> <p>(c) (i) <math>\frac{1}{3}t</math> final answer</p> <p>(ii) <math>\frac{1}{3}(-t + r)</math> final answer</p> <p>(iii) <math>\frac{1}{3}r</math> final answer</p> <p>(iv) <math>QP = \frac{1}{3}OR</math> oe <math>QP</math> is parallel to <math>OR</math> or <math>r</math></p>	<p>1 1</p> <p>1ft 1</p> <p>1 1</p> <p>1ft 1</p> <p>1</p> <p>1ft 1</p> <p>1</p> <p>2ft</p> <p>1</p> <p>2</p> <p>2</p> <p>1dep 1dep</p>	<p>The marks for the reasons are <b>dependent</b> on the correct angle or correct ft angle Any incorrect statement in reason loses that mark</p> <p>ft 90 – their <math>w</math> Allow diameter</p> <p>ft 180 – their <math>(w + x + y)</math> or 90 – their <math>y</math></p> <p>ft <math>\begin{pmatrix} 0 \\ 7 \end{pmatrix}</math> – their (i) <b>B1</b> ft for one correct element</p> <p><b>M1</b> for correct unsimplified answer or <math>TR = -t + r</math> oe or <math>TP = \frac{1}{3}TR</math> oe</p> <p><b>M1</b> for correct unsimplified answer or <math>QT + TP</math> oe for any correct path or <math>\frac{1}{3}t +</math> their (ii)</p> <p><b>Dependent</b> on correct answer in (iii)</p> <p><b>Dependent</b> on multiple of <math>r</math> as answer in (iii)</p>
---	---	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

4	<p><b>4 (a)</b> <math>(\cos(A)) = \frac{6^2 + 8^2 - 9^2}{2 \cdot 6 \cdot 8}</math> 78.58... www 4</p> <p><b>(b)</b> <b>(i)</b> 78.6 <b>(ii)</b> <math>r = \frac{4.5}{\sin(78.6)}</math> oe 4.590 to 4.591 cao www 3</p> <p><b>(c)</b> 35.5 (35.48 to 35.57...) cao www 4</p>	<p>M2 A2 1 M2 A1 4</p>	<p>M1 for correct implicit equation with <math>\cos A</math> A1 for 0.1979 to 0.198 (this implies M2) Allow 78.58... (M1 for <math>\sin(78.6) = \frac{4.5}{r}</math>) Allow 78.58... or their angle <i>BOM</i> for M2 or M1 M1 Area triangle = <math>0.5 \times 6 \times 8 \times \sin(78.6)</math> oe Allow 78.58.. (23.52..) M1 Circle = <math>\pi \times 4.59^2</math> Allow 4.590 to 4.591 (66.15 to 66.22...) M1 (<b>dependent</b>) % = triangle / circle <math>\times 100</math> Dependent on first 2 M's</p>
5	<p><b>3 (a)</b> <b>(i)</b> 50 www3 <b>(ii)</b> Angle <i>DCB</i> <math>\neq</math> angle <i>CBE</i> oe</p> <p><b>(b)</b> 12</p> <p><b>(c)</b> 65 www</p>	<p>3 1 B3 3</p>	<p><b>B1</b> for angle <i>ADB</i> or <i>ABD</i> = 70 <b>B1</b> for angle <i>DBC</i> = 80 Accept angle <i>CDB</i> <math>\neq</math> angle <i>ABD</i> <b>M2</b> for <math>\frac{5n}{2} = \frac{360}{n}</math> oe or <b>M1</b> for 360 soi <i>OAC</i> = 25, <i>CAB</i> = 25, <i>OBA</i> = 50, <i>BOC</i> = 50, <i>AOB</i> = 80, <i>AOC</i> = 130 <b>B1</b> each, max 2</p>
6	<p><b>4 (a)</b> 90</p> <p><b>(b)</b> <math>\tan(ACB) = 7 \div 10</math> oe 34.9(9...)</p> <p><b>(c)</b> <b>same segment</b></p> <p><b>(d) (i)</b> 11.9 or 11.8(9...) www 3</p> <p><b>(ii)</b> 38.6 (38.58 to 38.62) www 2</p> <p><b>(e)</b> 8.69 or 8.7(0) or 8.685 to 8.700.... cao www 3</p>	<p><b>B1</b> <b>M1</b> <b>A1</b> <b>B1</b> 3 2 3</p>	<p>Any longer method must reach equivalent stage Allow <b>same arc</b> oe <b>M2</b> for <math>\frac{7 \times \sin 77}{\sin 35}</math> or <b>M1</b> for implicit form <b>M1</b> for <math>0.5 \times 7 \times \text{their (d)(i)} \times \sin(180 - 77 - 35)</math> oe Allow 68.00 to 68.01 for 68 <b>M2</b> for <math>12.3 \times \left(\frac{10}{\text{their } 11.9}\right)^2</math> or <b>M1</b> for <math>\left(\frac{10}{\text{their } 11.9}\right)^2</math> or reciprocal seen</p>

7	4	<p>(a) (i) 42 Alternate oe</p> <p>(ii) 90 semicircle oe</p> <p>(iii) 42 same segment oe</p> <p>(iv) 138 cyclic quad oe</p> <p>(b) 10.9 (10.90 to 10.91) www 3</p> <p>(c) (i) <math>AD = CD</math> and <math>DE = DG</math> (Angle) <math>CDG = (\text{angle})ADE</math> (Sides of) square or <math>90^\circ + \text{angle } ADG</math> oe</p> <p>(ii) Congruent</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>3</p> <p>1</p> <p>1</p> <p>R1</p> <p>1</p>	<p>In all parts of (a) candidates may refer to angles marked in diagram. Allow if clear even if reason is more complicated as long as it is full. Reasons dependent on correct answers</p> <p>Not <b>alternate segment</b></p> <p>Allow <b>diameter</b></p> <p><b>same arc</b></p> <p><b>key words must not be spoiled</b></p> <p>M2 for <math>\sqrt{12^2 - 5^2}</math> oe i.e explicit or M1 for <math>12^2 = 5^2 + PQ^2</math> oe i.e implicit Allow full marks for <math>\sqrt{119}</math> as final answer Use of trig method must be complete to explicit expression for possible M2</p> <p>Extra pair of sides loses this mark. Extra pair of angles loses this mark As in (a), for all 3 marks allow references to diagram if completely clear. R mark dep on at least one pair of sides stated or pair of angles stated</p>
8	6	<p>(a) <math>(x =) 64</math> www 3</p> <p>(b) (i) -1 <math>n^2</math> oe <math>5n</math> oe <math>n^2 + 5n</math> oe</p> <p>(ii) 20</p> <p>(c) <b>Final answer</b> <math>\frac{x-4}{2x-1}</math> cao www 4</p>	<p>3</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>2</p> <p>4</p>	<p>B2 for <math>x + 2x + x = 360 - 114 + 10</math> or M1 for <math>x + 2x + 114 + x - 10 =</math></p> <p>M1 for their <math>n^2 + 5n = 500</math> or 20 and 25 seen</p> <p>B1 for <math>(x - 4)(x + 4)</math> B2 for <math>(2x - 1)(x + 4)</math> or SC1 for <math>(2x + a)(x + b)</math> where either <math>a + 2b = 7</math> or <math>ab = -4</math></p>

9	8	<p>(a) <math>u = 24</math> <math>v = 92</math> <math>w = 184</math></p> <p>(b) 10.8</p> <p>(c) (i) 18 (ii) 72 (iii) 54</p>	<p>2 1 1ft</p> <p>2</p> <p>2</p> <p>2ft</p> <p>1</p>	<p>SC1 for angle <math>DBA = 88</math> or <math>u = \text{angle } CDY</math></p> <p>ft <math>2 \times</math> their <math>v</math> Allow all seen in diagram</p> <p>M1 for area factor of <math>3^2</math> soi e.g. dividing by 9</p> <p>M1 for <math>4x + x = 90</math> or better</p> <p>ft <math>90 -</math> their <math>x</math> or <math>4 \times</math> their <math>x</math> M1 for angle <math>K</math> or <math>I = 90 -</math> their <math>x</math> or <math>4 \times</math> their <math>x</math> Allow all seen in diagram</p>
10	7	<p>(a) (i) <math>360 \div 5</math> (ii) <math>(180 - 72) \div 2</math> <math>54 \times 2</math> (iii) <math>180 - 90 - 72</math></p> <p>(b) <math>2 \times 7 \times \sin(72/2)</math> oe  8.228 to 8.229</p> <p>(c) (i) 23.3[0..] (ii) 116.5 to 116.52 or 117 (iii) 30.78 to 30.8 (iv) 12.66 to 12.67 or 12.7</p> <p>(d) 1.43 or 1.432 to 1.453 cao</p>	<p>1</p> <p>M1</p> <p>E1</p> <p>1</p> <p>M2</p> <p>E1</p> <p>2</p> <p>1 ft</p> <p>2</p> <p>2</p> <p>2</p> <p>5</p>	<p>Accept longer correct methods</p> <p>Accept <math>[(5 - 2) \times 180]</math> or <math>360 / 5</math> M1 Then <math>\div 5</math>                      <math>180 - 72</math> E1</p> <p>Accept other methods provided they are fully explained</p> <p>M1 for <math>7 \times \sin(72/2)</math> oe <u>Alt methods</u> M2 for <math>[DC^2 =] 7^2 + 7^2 - 2 \cdot 7 \cdot 7 \cos 72</math> or M1 for implicit version or M2 for <math>(7 \sin 72) / \sin 54</math> or M1 for <math>DC / \sin 72 = 7 / \sin 54</math> oe</p> <p>E1 Dep on M2 and with no errors seen</p> <p>M1 for <math>\frac{1}{2} \times 7 \times 7 \times \sin 72</math> oe</p> <p>ft their (c)(i) <math>\times 5</math></p> <p>M1 for <math>72/360 \times \pi 7^2</math></p> <p>M1 for <math>7 + 7 \cos 36</math> oe                      <math>[7 + 5.66\dots]</math> e.g <math>8.23 \cos 54 + 8.23 \sin 72</math> oe                      <math>[4.84 + 7.83]</math></p> <p>B4 for area of rectangle = 168.3 to 169.2 www or area of triangular corners = 51.6 to 52.5 www or B3 for 13.3 to 13.32 seen or M2 for <math>[ZY =] 8.23 + 2(8.23 \sin 18)</math> oe or <math>2(8.23 \sin 54)</math> or <math>2 \times 7 \sin 72</math> oe or B1 for <math>[CY =] 2.54[3]</math> or 5.08 to 5.09 seen or <math>[AX =] 6.65</math> to 6.66 seen</p>

11	4	(a) (i) 148	2	<b>B1</b> for tangent/radius = $90^\circ$ seen. May be on diagram
		(ii) 74	1ft	ft <i>their</i> (a)(i) $\div 2$ dep on (a)(i) $< 180$
		(iii) 21	2	<b>M1</b> for $360 - 90 - 143 - 32 - \textit{their} (ii) oee.g. using quadrilateral AOCD$
		(iv) 20.9 or 20.92...	3	<b>M2</b> for $6 \tan 74$ oe or explicit sine rule Or <b>M1</b> for implicit version
		(b) (i) 51	2	<b>M1</b> for $ABC = 90^\circ$ . May be on diagram.
		(ii) 56	2	<b>M1</b> for $39 + 17$ or $180 - (73 + \textit{their} 51)or [AXB =] 180 - (39 + 17)$
		(iii) <u>Angle at centre twice</u> oe angle at <u>circumference</u>	1	
		(iv) 22	1	
		(v) 68.3 or 68.27 to 68.29	3	Allow $\frac{326}{15} \pi$ as final answer <b>M2</b> for $\frac{360-34}{360} \times 2\pi \times 12$ or $2\pi \times 12 - \frac{34}{360} \times 2\pi \times 12$ or $\pi \times 12 + \frac{180-34}{360} \times 2\pi \times 12$ or <b>M1</b> for use of $\frac{\theta}{360} \times 2\pi \times 12$ for $\theta \neq$ multiples of $90^\circ$

12	8	<p>(a) 24</p> <p>(b) 5 www</p> <p>(c) 6.32 to 6.34 www</p>	<p>3</p> <p>3</p> <p>5</p>	<p><b>M2</b> for 24 at <i>B</i> or 128 at <i>X</i> and 28 at <i>D</i>. or <b>M1</b> for 28 at <i>D</i> or 128 at <i>X</i> allow on diagram</p> <p><b>M2</b> for <math>360 - 22x = 2 \times 25x</math> oe or better or <math>22x = 2(180 - 25x)</math> oe or better or <math>11x + 25x = 180</math> oe or better or <b>M1</b> for <math>P = 11x</math> or reflex <math>O = 360 - 22x</math> or reflex <math>O = 50x</math> allow on diagram</p> <p><b>B1</b> for <math>OLM = 90^\circ</math> (seen or implied) allow on diagram and <b>M1</b> for <math>LM = 8 \tan 44</math> [7.7255...] or <math>OM = 8 \div \cos 44</math> [11.1213...] and <b>M1dep</b> on previous <b>M</b> for <math>0.5 \times 8 \times \text{their } LM</math> or <math>0.5 \times 8 \times (\text{their } OM) \sin 44</math> and <b>M1</b> for <math>\frac{44}{360} \times \pi \times 8^2</math> oe [24.5 to 24.6]</p>
13	8	<p>(a) (i) 118</p> <p>(ii) 31</p> <p>(iii) 22</p> <p>(b) 32</p> <p>(c) (i) Opposite angles [cyclic quad] add to 180</p> <p>(ii) 68</p> <p>(d) 5.75</p>	<p>2</p> <p>1FT</p> <p>1FT</p> <p>4</p> <p>1</p> <p>3</p> <p>3</p>	<p><b>M1</b> for <math>(3 \times 180 - 2 \times 110 - 84) \div 2</math> or better</p> <p>FT <math>(180 - \text{their (i)}) \div 2</math></p> <p>FT <math>84 - 2 \times \text{their (ii)}</math> or <math>2 \times \text{their (ii)} - 40</math>, only if positive answer and less than 84</p> <p><b>B2</b> for <math>360 - 3y = 2(4y + 4)</math> oe and <b>B1</b> for <math>11y = 352</math> oe or <b>M1</b> for angle at centre = <math>2 \times</math> angle at circumference soi</p> <p><b>M1</b> for [angle <math>PRS =</math>] <math>102 \div 3 \times 2</math> and <b>M1</b> for angle <math>PQS =</math> angle <math>PRS</math> or angle <math>PRQ =</math> angle <math>PSQ</math></p> <p><b>M2</b> for <math>6.9 \times \sqrt{\frac{5}{7.2}}</math> oe or <b>M1</b> for evidence of ratio of areas = (ratio of sides)<sup>2</sup> or sf = 1.2</p>



14	4	<p>(a) 227 or 226.95 to 227.01</p> <p>(b) 5.35</p> <p>(c) 39.0[0] to 39.0[1]</p> <p>(d) 30.2 or 30.3 or 30.24 to 30.27</p> <p>(e) <math>AB = BC</math> <math>TA = TC</math> <math>TB = TB</math></p>	<p>2</p> <p>1</p> <p>2</p> <p>3</p> <p>1</p> <p>1</p> <p>1</p>	<p><b>M1</b> for <math>\pi \times 8.5^2</math></p> <p><b>M1</b> for <math>\sin [MOB] = \frac{\text{their } b}{8.5}</math> oe Dep on their <math>b &lt; 8.5</math></p> <p><b>M2</b> for <math>\frac{360 - 4 \times 39}{360} \times 2 \times \pi \times 8.5</math> oe or <b>M1</b> for <math>\frac{a}{360} \times 2 \times \pi \times 8.5</math> oe where <math>0 &lt; a &lt; 360</math></p> <p>Implied by 5.78 to 5.79 or 11.5 to 11.6 or 23.14 to 23.15 or 23.1 or 23.2 or 41.83 to 41.84 or 41.8</p> <p>isw comments or reasons</p> <p>If 0 scored <b>SC1</b> for “all <u>three sides</u> the same” oe [SSS] and no mention of angles</p>
15	8	<p>(a) (i) 27</p> <p>(ii) 54</p> <p>(iii) 153</p> <p>(b) (i) 59.6 or 59.57... www</p> <p>(ii) 22.[0] or 21.99... www</p> <p>(iii) 81[.0]</p>	<p>1</p> <p>1</p> <p>1</p> <p>4</p> <p>3</p> <p>2</p>	<p><b>M2</b> for <math>45^2 + 32^2 - 2 \times 45 \times 32 \times \cos 100</math> <b>or M1</b> for implicit cos rule <b>and A1</b> for 3549....</p> <p><b>M2</b> for <math>324 \div (\frac{1}{2} \times 32 \times \sin 67)</math> <b>or M1</b> for <math>[324 =] \frac{1}{2} \times 32 \times x \times \sin 67</math></p> <p><b>B1</b> for <math>2^2</math> or <math>(\frac{1}{2})^2</math> oe seen or <math>\frac{1}{2} \times 16 \times \frac{1}{2}</math> their(b)(ii) <math>\times \sin 67</math></p>
16	4	<p>(a) 48 and 84 66 and 66</p> <p>(b) 540</p> <p>(c) 1620</p> <p>(d) (i) <math>2x + 5 + 3y - 20 + 4x - 5 + x + y - 10 = 360</math> oe</p> <p>(ii) <math>2x + 5 + 3y - 20 = 180</math></p> <p>(iii) <math>[x =] 30, [y =] 45</math> nfw</p> <p>(iv) 65, 115, 115, 65</p>	<p>2</p> <p>2</p> <p>2</p> <p>1</p> <p>1</p> <p>4</p> <p>1</p>	<p><b>B1</b> for each pair</p> <p><b>M1</b> for <math>3 \times 180</math> or <math>(2 \times 5 - 4) \times 90</math> or <math>5 \times (180 - 360 \div 5)</math> oe</p> <p><b>M1</b> for <math>7 \times 360 - \text{their } 540 - 360</math></p> <p>Allow partial simplification but not <math>7x + 4y - 30 = 360</math></p> <p><b>M1</b> for correct multiplication <b>M1</b> for correct elimination <b>A1</b> <math>x = 30</math> or <math>y = 45</math></p> <p>If 0 scored <b>SC1</b> for correct substitution to find the other variable</p> <p>Accept in any order</p>

17	6	<p>(a) (i) <math>[x = ] 21, [y = ] 42</math></p> <p>(ii) 3.79 or 3.8[0] or 3.792 to 3.802</p> <p>(b) 40</p> <p>(c) 38</p>	<p>2</p> <p>2</p> <p>4</p> <p>5</p>	<p><b>B1 B1</b></p> <p><b>M1</b> for <math>\frac{3.31}{TQ} = \frac{8.23}{9.43}</math> oe or <math>\frac{\sin 21 \text{ or } \sin \text{their } x}{TQ} = \frac{\sin 117}{9.43}</math> oe</p> <p><b>B3</b> for angle between <math>HE</math> and tangent = 25 <b>or</b> <math>GFH = 40</math> <b>or</b> <math>EGH = 25</math> <b>and</b> angle <math>EHG = 115</math> (accept 90 and 25 at <math>H</math> for 115) <b>B2</b> for angle <math>EGH = 25</math> <b>or</b> angle <math>EHG = 115</math> (accept 90 and 25 at <math>H</math> for 115) <b>B1</b> for angle <math>FEG = 25</math> <b>or</b> angle <math>EFG = 65</math></p> <p><b>B4</b> for angle <math>ADC = 104</math> <b>or</b> <b>M4</b> for <math>x + 14 + 20 + x + 70 = 180</math> or better</p> <p><b>or</b> <b>B3</b> for angle <math>OBA = 20</math> <b>and</b> angle <math>OBC = 56</math> <b>or</b> angle <math>CBA = 76</math> <b>or</b> reflex angle <math>AOC = 208</math></p> <p><b>or</b> <b>B2</b> for angle <math>OAB</math> or <math>OBA = 20</math> <b>and</b> angle <math>ACB = 70</math> <b>or</b> obtuse angle <math>AOC = 152</math> <b>or</b> angle <math>BOC = 68</math></p> <p><b>or</b> <b>B1</b> for angle <math>OAB</math> or <math>OBA = 20</math> <b>or</b> angle <math>ACB = 70</math></p>
18	11	<p><math>\frac{1}{3}</math></p> <p><math>\frac{72}{360}</math> oe</p> <p><math>\frac{1}{4}</math></p> <p><math>\frac{1}{6}</math></p> <p><math>\frac{\pi - 2}{\pi}</math> or <math>1 - \frac{2}{\pi}</math> or 0.363 or 0.3630 to 0.3635</p>	<p>1</p> <p>1</p> <p>2</p> <p>2</p> <p>4</p>	<p>Allow equivalent decimal throughout (3sf or better where necessary)</p> <p><b>M1</b> for <math>\left(\frac{1}{2}\right)^2</math> or <math>(2)^2</math> or <math>1^2 : 2^2</math> or <math>2^2 : 1^2</math> oe seen</p> <p><b>M1</b> for <math>[X = 6 \times ] 0.5 \times l^2 \times \sin 60</math> or <math>[X = 6 \times ] 0.5 \times l^2 \times \sin 120</math> Or recognition that the area of the obtuse-angled triangle shaded is equal to the area of one of the 6 equilateral triangles from the centre</p> <p>If fraction given as answer, check if it falls into range</p> <p><b>B1</b> for [sector =] <math>\frac{1}{4}\pi r^2</math> oe</p> <p><b>B1</b> for [triangle =] <math>\frac{1}{2}r^2</math> oe</p> <p><b>M1dep</b> for <math>\frac{\text{their sector} - \text{their triangle}}{\text{their sector}}</math> dep on <b>B1B1</b> earned</p>

19	7	<p>(a) (i) 148</p> <p>(ii) 122</p> <p>(iii) 148</p> <p>(iv) 106 nfw</p> <p>(b) (i) 63</p> <p>(ii) 54</p>	<p>1</p> <p>2</p> <p>1</p> <p>3</p> <p>2</p> <p>2</p>	<p><b>B1</b> for 58 seen at <math>A</math> or 32 seen at <math>Y</math></p> <p><b>B1</b> for [sum of interior angles =] 720 and <b>M1</b> for <math>\frac{1}{2} \{(their\ 720) - (p+q+t+90)\}</math></p> <p><b>B1</b> for angle <math>RPS = 27</math> or <math>90</math> at <math>P</math> or at <math>S</math> seen or stated</p> <p><b>B1</b> for <i>their</i> <math>x</math> or 63 or letter <math>x</math> at <math>Q</math> seen or state</p>
20	3	<p>(a) (i) 52 Angles in <b>same segment</b></p> <p>(ii) 104 <b>Angle at centre is twice</b> angle at <b>circumference</b></p> <p>(iii) 34 Angle between <b>tangent</b> and <b>radius</b> = <math>90^\circ</math></p> <p>(b) (i) 7.65 to 7.651</p> <p>(ii) 49.3 or 49.33 to 49.34...</p>	<p>1</p> <p><b>1dep</b></p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>4</p> <p>3</p>	<p>Accept same arc, same side of same chord</p> <p>Accept double, <math>2 \times</math> but not middle, edge</p> <p>Accept right angle, perpendicular</p> <p><b>M2</b> for <math>8.92 + 72 - 2 \times 8.9 \times 7 \times \cos 56</math> or <b>M1</b> for correct implicit formula and <b>A1</b> for 58.5 to 58.6</p> <p><b>M2</b> for <math>[\sin BEC =] \frac{7 \sin 56}{their\ (b)(i)}</math> oe or <b>M1</b> for <math>\frac{\sin 56}{their\ (b)(i)} = \frac{\sin BEC}{7}</math> oe</p>

21	7	<p>(a) <math>\frac{1}{2} \times 8 \times 8 \times \sin 56</math> oe 26.52 to 26.53</p> <p>(b) (i) 72.[0] or 71.87 to 72.0</p> <p>(ii) 21.1 or 21.2 or 21.14 to 21.17</p> <p>(c) (i) <math>\frac{30}{360} \times \pi \times r^2 - \frac{1}{2} \times r^2 \times \sin 30</math> oe <math>\frac{1}{12} \times \pi \times r^2 - \frac{1}{4} \times r^2</math> <math>\frac{1}{4} r^2 \left( \frac{1}{3} \pi - 1 \right)</math></p> <p>(ii) 20.6 or 20.7 or 20.55 to 20.71</p>	<p><b>M1</b></p> <p><b>A1</b></p> <p><b>3</b></p> <p><b>3</b></p> <p><b>M2</b></p> <p><b>A1</b></p> <p><b>A1</b></p> <p><b>3</b></p>	<p>or <math>[\frac{1}{2} \times 2] 8 \sin 28 \times 8 \cos 28</math> or <math>[\frac{1}{2} \times 2] \times 7.06... \times 3.75...</math></p> <p><b>M2</b> for <math>26.5 / (\pi \times 6.5^2) \times 360</math> oe or <b>M1</b> for <math>\frac{x}{360} \times \pi \times 6.5^2 = 26.5</math> or better</p> <p><b>M2</b> for <math>\frac{\text{their (b)(i)}}{360} \times \pi \times 2 \times 6.5 + 2 \times 6.5</math> oe or <b>M1</b> for <math>\frac{\text{their (b)(i)}}{360} \times \pi \times 2 \times 6.5</math> oe or <math>\frac{\text{their (a)}}{0.5 \times 6.5}</math></p> <p><b>M1</b> for <math>\frac{30}{360} \times \pi \times r^2</math> or <math>\frac{1}{2} \times r^2 \times \sin 30</math></p> <p>Dep on <b>M2 A1</b> and no errors seen</p> <p><b>M2</b> for <math>[r^2 =] \frac{1}{4} \left( \frac{5}{\frac{1}{3} \pi - 1} \right)</math> or <b>M1</b> for one correct rearrangement step to <math>r</math> from <math>\frac{1}{4} r^2 \left( \frac{1}{3} \pi - 1 \right) = 5</math></p>
22	9	<p>(a) (i) 42</p> <p>(ii) 111</p> <p>(b) (i) 37.7 or 37.69 to 37.704 nfw</p> <p>(ii) 12100, 12060, 12070, 12062.4 to 12065.6 nfw</p>	<p><b>2</b></p> <p><b>2</b></p> <p><b>2</b></p> <p><b>5</b></p>	<p><b>B1</b> for <math>BAC = 90 - 48</math></p> <p><b>B1</b> for 111 or 69 or <math>ACD = 27</math> correctly placed on diagram or indicated</p> <p><b>M1</b> for <math>6\pi + 4\pi \pm 2\pi</math> oe</p> <p><b>SC4</b> for answer with figs 121 or 1206 to 1207</p> <p><b>OR</b></p> <p><b>M2</b> for total area = <math>\frac{1}{2} \pi 6^2 + \frac{1}{2} \pi 4^2 - \frac{1}{2} \pi 2^2</math> or <math>\frac{1}{2} \pi 60^2 + \frac{1}{2} \pi 40^2 - \frac{1}{2} \pi 20^2</math> or</p> <p><b>M1</b> for <math>\frac{1}{2} \pi 6^2</math> or <math>\frac{1}{2} \pi 4^2</math> or <math>\frac{1}{2} \pi 2^2</math> or <math>\frac{1}{2} \pi 60^2</math> or <math>\frac{1}{2} \pi 40^2</math> or <math>\frac{1}{2} \pi 20^2</math></p> <p><b>A1</b> for area = 75.39 to 75.41 or 7539 to 7541</p> <p><b>and</b></p> <p><b>M1 dep</b> for volume = <i>their</i> area <math>\times</math> thickness</p>

23	2	<p>(a) (i) 66</p> <p>(ii) 24</p> <p>(iii) 66</p> <p>(iv) 114</p> <p>(b) 83.6 or 83.60[...]</p> <p>(c) Opposite angles add up to 180 OR Angle in a semicircle [=90]</p>	<p>1</p> <p>1FT</p> <p>2FT</p> <p>1FT</p> <p>2</p> <p>1</p>	<p><b>FT 90 – their (a)(i)</b></p> <p><b>FT 90 – their (a)(ii)</b> <b>M1</b> for [<math>BOD =</math>] <math>180 - 48</math> or <math>180 - 2 \times</math> <b>their (a)(ii)</b></p> <p><b>FT 180 – their (a)(iii)</b></p> <p><b>M1</b> for <math>\frac{1}{2} \times 15 \times 15 \times \sin(180 - 48)</math> oe or <math>\frac{1}{2} \times 15 \times 15 \times \sin(180 - 2 \times</math> <b>their (a)(ii)</b>) oe</p> <p><b>1</b></p>
24	6	<p>(a) 100 nfw</p> <p>(b) (i) 50</p> <p>(ii) 41</p> <p>(iii) Similar</p> <p>(c) 27.8 or 27.83</p> <p>(d) (i) 60</p> <p>(ii) 174</p>	<p>4</p> <p>2</p> <p>2FT</p> <p>1</p> <p>2</p> <p>3</p> <p>2</p>	<p><b>M3</b> for a correct calculation that would lead to the answer or <b>B2</b> two correct relevant different size angles in <i>their</i> diagram or one relevant angle <b>and</b> total in <i>their</i> polygon or angle <math>EDA +</math> angle <math>FAD = 140</math> or <b>B1</b> for one relevant angle or total in <i>their</i> polygon</p> <p><b>B1</b> for angle <math>ADC = 80</math> or angle <math>BAC = 30</math> or angle <math>ADB = 50</math> soi</p> <p><b>FT 91 – their (b)(i)</b> <b>B1</b> for angle <math>XBC = 41</math></p> <p><b>1</b></p> <p><b>2</b> <b>M1</b> for evidence of <math>\left(\frac{11}{10}\right)^2</math> or 1.21 or <math>\left(\frac{10}{11}\right)^2</math> or 0.826(4...)</p> <p><b>3</b> <b>M2</b> for <math>\frac{n}{10} = \frac{360}{n}</math> oe e.g. <math>\frac{180(n-2)}{n} = 180 - \frac{n}{10}</math> or <b>B1</b> for exterior sum = 360 or <math>180(n-2)</math> seen</p> <p><b>2</b> <b>M1</b> for <math>\frac{\text{their } n}{10}</math> or <math>\frac{360}{\text{their } n}</math> for <i>their</i> <math>n &lt; 1800</math></p>

25	5	<p>(a) 37 or [angle] <math>BAD</math></p> <p>[Angles in ] same segment [are equal]</p> <p>(b) 74 or 2 [<math>\times</math> angle] <math>BAD</math> or 2 [<math>\times</math> angle] <math>BED</math></p> <p>Angle at <u>centre</u> is twice angle at <u>circumference</u></p> <p>(c) 143 or <math>180 - [\text{angle}] BAD</math> or <math>180 - [\text{angle}] BED</math></p> <p>[Opposite angles of] cyclic quad [are supplementary]</p>	<p>1</p> <p>1dep</p> <p>1</p> <p>1dep</p> <p>1</p> <p>1dep</p>	<p>Dependent on 37 or [angle] <math>BAD</math></p> <p>Dependent on <math>2 \times 37</math> or 2 [<math>\times</math> angle] <math>BAD</math> or 2 [<math>\times</math> angle] <math>BED</math></p> <p>Must use the terms circumference, centre and angle</p> <p>Dependent on <math>180 - 37</math> or <math>180 - [\text{angle}] BAD</math> or <math>180 - [\text{angle}] BED</math></p>
26	8	<p>(a) (i) Angle <math>A</math> is common to both triangles oe <math>ADB = ABC</math> Third angle of triangles equal oe</p> <p>(ii) Similar</p> <p>(iii) 8.25</p> <p>(b) (i) 38</p> <p>(ii) 38</p> <p>(iii) 78</p> <p>(iv) 26</p> <p>(c) 36 nfw</p>	<p>1</p> <p>1dep</p> <p>1</p> <p>2</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>5</p>	<p>Accept <math>DAB = CAB</math> oe</p> <p>Dep on previous mark</p> <p>M1 for <math>\frac{16}{12} = \frac{11}{BD}</math> oe or better</p> <p>B4 for an equation in <math>m</math> that simplifies to <math>5m = 180</math> or</p> <p>B1 for each of 3 of the listed angles expressed in terms of <math>m</math>, in it's simplest form, stated or labelled on diagram</p> <p>Angle <math>PQO = m</math> Angle <math>QOR = m</math> Angle <math>OQR = 2m</math></p> <p>Angle <math>PQR = 3m</math> or <math>180 - 2m</math> or <math>90 + \frac{m}{2}</math></p> <p>Angle <math>POR = 180 - m</math> or <math>4m</math> or <math>360 - 6m</math></p> <p>Reflex angle <math>POR = 360 - 4m</math> or <math>6m</math> or <math>180 + m</math></p>

27	7	<p>(a) <math>360 - 210 [= 150]</math>  <math>(180 - 150) \div 2 [= 15]</math>  <b>or</b> <math>150 \div 2 [=75]</math> and <math>180 - 75 - 90</math>  <math>[=15]</math></p> <p>(b) 15.5 or 15.45 to 15.46 nfw</p> <p>(c) 29.5 or 29.4 or 29.39 to 29.50..</p> <p>(d) 194 or 193.7 to 194.1 nfw</p> <p>(e) 12.1 or 12.11 to 12.13</p>	<p><b>M1</b> <b>M1</b></p> <p><b>4</b></p> <p><b>3</b></p> <p><b>6</b></p> <p><b>2FT</b></p>	<p><b>M3</b> for <math>2 \times 8 \cos 15</math> oe  <b>or M2</b> for <math>8 \cos 15</math> oe  <b>or M1</b> for <math>\frac{x}{8} = \cos 15</math> oe</p> <p><b>M2</b> for <math>[\sin ABC = ] \frac{8 \times \sin 72}{\text{their}(b)}</math>  <b>or M1</b> for <math>\frac{\sin ABC}{8} = \frac{\sin 72}{\text{their}(b)}</math> oe</p> <p><b>M2</b> for <math>\frac{210}{360} \times \pi \times 8^2</math>  <b>or M1</b> for <math>[k] \pi \times 8^2</math> seen</p> <p><b>and</b>  <b>M1</b> for <math>\frac{1}{2} \times 8^2 \times \sin 150</math> oe</p> <p><b>and M2</b> for <math>\frac{1}{2} \times 8 \times \text{their}(b) \times \sin(108 - \text{their}(c))</math> oe  <b>or B1</b> for <math>[\text{angle } CAB=] 108 - \text{their}(c)</math></p> <p><b>FT</b> <math>\text{their}(d) \div 4^2</math> oe  <b>M1</b> for <math>4^2</math> or <math>\left(\frac{1}{4}\right)^2</math> soi</p>
28	2(a)	122	<b>4</b>	<p><b>B3</b> for 238 or 61 or 58 correctly identified in working or on diagram  <b>or B2</b> for 952 seen  <b>or 74 or 119 or 29</b> correctly identified in working or on diagram  <b>OR</b>  Method 1 using sum of interior angles  <b>M1</b> for <math>(8 - 2) \times 180</math> or 1080 isw  <b>M1</b> for <math>\text{their } 1080 - 4 \times 32</math>  <b>M1</b> for <math>360 - \text{their } 952 \div 4</math>  <b>OR</b>  Method 2 using isosceles triangles and square  <b>M1</b> for <math>(180 - 32) \div 2</math> or for 90  <b>M1</b> for <math>\text{their } 74 \times 2 + 90</math> or <math>90 - \text{their } 74</math>  <b>M1</b> for <math>360 - \text{their } 74 \times 2 + 90</math>  <b>or</b> <math>90 + 2(90 - \text{their } 74)</math>  <b>OR</b>  Method 3 using four kites joined to centre  <b>M1</b> for <math>360 \div 4</math>  <b>M1</b> for <math>(360 - (\text{their } 90 + 32)) \div 2</math>  <b>M1</b> for <math>2(180 - \text{their } 119)</math>  <b>OR</b>  Method 4 using square around outside  <b>M1</b> for <math>90 - 32</math>  <b>M1</b> for <math>(90 - 32) \div 2</math>  <b>M1</b> for <math>180 - 2(\text{their } 29)</math></p>

	2(b)	105	3	<p><b>M2</b> for <math>360 = 2 \times y + (2y - 60)</math> oe or <math>2(180 - y) = 2y - 60</math> oe</p> <p>or <b>B1</b> identifying in working or on diagram a relevant angle in terms of <math>y</math></p>
29	8(a)	18	3	<p><b>B2</b> for 20 nfw or <b>M1</b> for <math>8x + x = 180</math> or better</p>
	8(b)	32	3	<p><b>B1</b> for angle <math>DBC = 58</math> <b>B1</b> for angle <math>BCD = 90</math></p>
	8(c)(i)	24	2	<p><b>B1</b> for angle <math>PRQ = 24</math></p>
	8(c)(ii)	29.4 or 29.40 to 29.41	3	<p><b>M2</b> for <math>\frac{360 - 48}{360} \times 2 \times \pi \times 5.4</math> or <b>B2</b> for answer (minor arc) 4.52 or 4.523 to 4.524... or <b>M1</b> for <math>\frac{48}{360} \times 2 \times \pi \times 5.4</math></p>
30	9(a)(i)(a)	62 and Isosceles [triangle] and Angle at centre is twice angle at circumference oe	3	<p><b>B2</b> for 62 and one correct reason or <b>B1</b> for 62 with no/wrong reason or for angle <math>EOD = 124</math> soi or for no/wrong angle with correct reason</p>
	9(a)(i)(b)	62 and [Angles in] same segment oe or angle at centre is twice angle at circumference oe	2	<p><b>2FT</b> <i>their (a)(i)(a)</i> and correct reason <b>B1FT</b> for <i>their (a)(i)(a)</i> with no/wrong reason or for no/wrong angle with correct reason</p>
	9(a)(ii)	8	3	<p><b>M2</b> for <math>(180 - 109) - 28 - 35</math> oe or <b>M1</b> for [angle <math>AED =</math>] <math>180 - 109</math> oe</p>
	9(b)(i)	24	3	<p><math>x =</math> ext angle <b>B2</b> for [<math>x =</math>] 15 isw or <b>M1</b> for <math>x + 11x = 180</math> oe or for <math>\frac{180(n-2)}{[n]} = \frac{360}{[n]} \times 11</math></p>
	9(b)(ii)	3960	2	<p><b>FT</b> (<i>their</i> <math>24 - 2</math>) <math>\times 180</math> dep on <b>(b)(i)</b> an integer and <math>&gt; 6</math> <b>M1</b> for (<i>their</i> <math>24 - 2</math>) <math>\times 180</math> oe or <i>their</i> <math>24 \times 11 \times</math> <i>their</i> 15 oe or <math>11 \times 360</math></p>



31	2(a)	103	3	<p><b>M1</b> for angle <math>ABC</math> or angle <math>ACB = \frac{1}{2}(180 - 26)</math> oe</p> <p><b>M1</b> for angle <math>ABF = 26</math> or angle <math>CBD</math> or angle <math>FBE = 77</math> or exterior angle <math>ACB = 103</math> correctly identified or in correct position</p>
	2(b)	75	5	<p><b>B4</b> for 105 at <math>a</math> or <math>b</math> <b>or</b> 73 at <math>c</math> <b>and</b> 32 at <math>d</math></p> <p>or <b>B3</b> for 58 at <math>m</math> <b>or</b> 58 at <math>e</math> <b>and</b> 17 at <math>k</math></p> <p>or <b>B2</b> for 32 at <math>d</math> <b>and</b> 90 soi at <math>(c+k)</math> <b>or</b> 32 at <math>d</math> <b>and</b> 17 at <math>k</math> <b>or</b> 73 at <math>c</math></p> <p>or <b>B1</b> for 90 soi at <math>(c + k)</math> or between tangent and radius <b>or</b> 32 at <math>d</math> <b>or</b> 17 at <math>k</math></p>
32	4(a)	65.4 or 65.36 to 65.37	3	<p><b>M1</b> for <math>150^2 + 120^2 - 2 \times 150 \times 120 \cos 25</math> <b>A1</b> for 4270 or 4272 to 4273</p>
	4(b)	125 or 124.7 to 124.8	4	<p><b>B1</b> for [angle <math>S =</math>] 80</p> <p><b>M2</b> for <math>\frac{150 \sin 55}{\sin their 80}</math></p> <p>or <b>M1</b> for <math>\frac{\sin their 80}{150} = \frac{\sin 55}{RS}</math> oe</p>
	4(c)	10 400 or 10 410 to 10 440 nfw	3	<p><b>M1</b> for <math>\frac{1}{2} \times 120 \times 150 \sin 25</math> oe</p> <p><b>M1</b> for <math>\frac{1}{2} \times 150 \times their (b) \sin 45</math> oe</p>

33	4(a)	38.6	3	<b>M2</b> for $[2 \times] (8.5 + 0.05 + 10.7 + 0.05)$ or <b>M1</b> for $8.5 + 0.05$ or $10.7 + 0.05$
	4(b)(i)	8.86 or 8.863...	2	<b>M1</b> for $\frac{h}{9} = \sin 80$ or better oe
	4(b)(ii)	$\angle CDF = 100$ leading to $\angle DCF = 40$ Or $\angle EDF = 80$ leading to $\angle DCF = 40$  'two equal angles'	<b>M1</b>	Implied by $180 - (100 + 40) = 40$ or $80 - 40$
	4(b)(iii)	66.5 or 66.45 to 66.47...	<b>A1</b>	With no incorrect work seen
	4(c)	130 nfw or 129.6 to 129.8	3	<b>M2</b> for $0.5(3 + 12) \times \text{their (b)(i)}$ or $12 \times \text{their (b)(i)} - 0.5 \times 9 \times 9 \times \sin 100$ oe or <b>B1</b> for $DC = 9$ or $BC = 3$
			5	<b>B1</b> for $\angle ACD = 21^\circ$ or $\angle CAD = 69^\circ$  <b>Method 1</b> <b>M2</b> for $\cos 21 = \frac{12}{AC}$ oe or <b>M1</b> for $\angle ADC = 90$ soi  <b>M1</b> for $\pi(\text{their } AC/2)^2$ OR <b>Method 2</b> <b>M2</b> for $\frac{12}{\sin 138} = \frac{r}{\sin 21}$ oe or <b>M1</b> for $\angle COD = 138$ soi  <b>M1</b> for $\pi(\text{their } r)^2$ OR <b>Method 3</b> <b>M2</b> for $\cos 21 = \frac{6}{OC}$ oe or <b>M1</b> for $\angle CXO = 90$ soi where X is the point where the perpendicular from O meets the chord CD  <b>M1</b> for $\pi(\text{their } OC)^2$
	4(d)	78.4 or 78.37 to 78.41	3	<b>M2</b> for $\frac{x}{360} \times 2 \times \pi \times 9.5 + 2 \times 9.5 = 4 \times 8$ oe  or <b>M1</b> for $\frac{x}{360} \times 2 \times \pi \times 9.5$  After <b>M0</b> , <b>SC1</b> for $9.5x + 19 = 32$ oe