

Extended Mathematics
Topic : Geometry
Year :May 2013 -May 2023

Paper -4

Answers

Question 1

(a) (i)	27	1	
(ii)	54	1	
(iii)	153	1	
(b) (i)	59.6 or 59.57... www	4	M2 for $45^2 + 32^2 - 2 \times 45 \times 32 \times \cos 100$ or M1 for implicit cos rule and A1 for 3549....
(ii)	22.[0] or 21.99... www	3	M2 for $324 \div (\frac{1}{2} \times 32 \times \sin 67)$ or M1 for $[324 =] \frac{1}{2} \times 32 \times x \times \sin 67$
(iii)	81[.0]	2	B1 for 2^2 or $(\frac{1}{2})^2$ oe seen or $\frac{1}{2} \times 16 \times \frac{1}{2}$ their(b)(ii) $\times \sin 67$

Question 2

(a)	227 or 226.95 to 227.01	2	M1 for $\pi \times 8.5^2$
(b)	5.35	1	
(c)	39.0[0] to 39.0[1]	2	M1 for $\sin [MOB] = \frac{\text{their } b}{8.5}$ oe Dep on their $b < 8.5$
(d)	30.2 or 30.3 or 30.24 to 30.27	3	M2 for $\frac{360 - 4 \times 39}{360} \times 2 \times \pi \times 8.5$ oe or M1 for $\frac{a}{360} \times 2 \times \pi \times 8.5$ oe where $0 < a < 360$ 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
(e)	$AB = BC$ $TA = TC$ $TB = TB$	1 1 1	isw comments or reasons If 0 scored SC1 for "all three sides the same" oe [SSS] and no mention of angles

Question 3

(a) (i)	118	2	M1 for $(3 \times 180 - 2 \times 110 - 84) \div 2$ or better
(ii)	31	1FT	FT $(180 - \textit{their (i)}) \div 2$
(iii)	22	1FT	FT $84 - 2 \times \textit{their (ii)}$ or $2 \times \textit{their (ii)} - 40$, only if positive answer and less than 84
(b)	32	4	B2 for $360 - 3y = 2(4y + 4)$ oe and B1 for $11y = 352$ oe or M1 for angle at centre = $2 \times$ angle at circumference soi
(c) (i)	Opposite angles [cyclic quad] add to 180	1	
(ii)	68	3	M1 for [angle $PRS =$] $102 \div 3 \times 2$ and M1 for angle $PQS =$ angle PRS or angle $PRQ =$ angle PSQ
(d)	5.75	3	M2 for $6.9 \times \sqrt{\frac{5}{7.2}}$ oe or M1 for evidence of ratio of areas = (ratio of sides) ² or sf = 1.2

Question 4

(a)	31.4	3	M2 for $\frac{15.7}{\sin 30}$ or M1 for correct implicit statement
(b)	$[\sin E =] \frac{15.7 \times \sin 52}{16.5}$ 48.573...	M2 A1	M1 for correct implicit statement
(c) (i)	$[\angle ACE =] 180 - 52 - 48.57$ [= 79.43]	M1	

	$[\angle ECD =] 40.57\dots$	A1	
(ii)	15.3 or 15.27 to 15.281 www	4	M2 for $[(DE)^2 =] 16.5^2 + 23.4^2 - 2 \times 16.5 \times 23.4 \cos(40.6 \text{ or } 40.57)$ or M1 for full correct implicit statement A1 for 233 to 234
(d)	466 or 466.34 to 466.5	4	M1 for $0.5 \times 15.7 \times \text{their } 31.4 \sin(90 - 30)$ oe M1 for $0.5 \times 15.7 \times 16.5 \sin(128 - \text{their } 48.6 \text{ or } 48.57)$ oe M1 for $0.5 \times 16.5 \times 23.4 \sin(40.6 \text{ or } 40.57)$ oe

Question 5

(a)	48 and 84 66 and 66	2	B1 for each pair
(b)	540	2	M1 for 3×180 or $(2 \times 5 - 4) \times 90$ or $5 \times (180 - 360 \div 5)$ oe
(c)	1620	2	M1 for $7 \times 360 - \text{their } 540 - 360$
(d) (i)	$2x + 5 + 3y - 20 + 4x - 5 + x + y - 10 = 360$ oe	1	Allow partial simplification but not $7x + 4y - 30 = 360$
(ii)	$2x + 5 + 3y - 20 = 180$	1	
(iii)	$[x =] 30, [y =] 45$ nfw	4	M1 for correct multiplication M1 for correct elimination A1 $x = 30$ or $y = 45$ If 0 scored SC1 for correct substitution to find the other variable
(iv)	65, 115, 115, 65	1	Accept in any order

Question 6

(a) (i)	148	1	
(ii)	122	2	B1 for 58 seen at A or 32 seen at Y
(iii)	148	1	
(iv)	106 nfw	3	B1 for [sum of interior angles =] 720 and M1 for $\frac{1}{2} \{(\text{their } 720) - (p+q+t+90)\}$

(b) (i)	63	2	B1 for angle $RPS = 27$ or 90 at P or at S seen or stated
(ii)	54	2	B1 for <i>their</i> x or 63 or letter x at Q seen or state

Question 7

(a) (i)	$[x =] 21, [y =] 42$	2	B1 B1
(ii)	3.79 or 3.8[0] or 3.792 to 3.802	2	M1 for $\frac{3.31}{TQ} = \frac{8.23}{9.43}$ oe or $\frac{\sin 21 \text{ or } \sin \text{their } x}{TQ} = \frac{\sin 117}{9.43}$ oe
(b)	40	4	B3 for angle between HE and tangent = 25 or $GFH = 40$ or $EGH = 25$ and angle $EHG = 115$ (accept 90 and 25 at H for 115) B2 for angle $EGH = 25$ or angle $EHG = 115$ (accept 90 and 25 at H for 115) B1 for angle $FEG = 25$ or angle $EFG = 65$
(c)	38	5	B4 for angle $ADC = 104$ or M4 for $x + 14 + 20 + x + 70 = 180$ or better or B3 for angle $OBA = 20$ and angle $OBC = 56$ or angle $CBA = 76$ or reflex angle $AOC = 208$ or B2 for angle OAB or $OBA = 20$ and angle $ACB = 70$ or obtuse angle $AOC = 152$ or angle $BOC = 68$ or B1 for angle OAB or $OBA = 20$ or angle $ACB = 70$

Question 8

(a) (i)	$5x + 14$ final answer	2	M1 for $5x + k$ or $kx + 14$
(ii)	14.2	3	M1 for $5x = 32 - 14$ FT <i>their</i> expression in (a)(i) A1FT for $x = 3.6$
(b)	$8a - 3b + 14 = 32.5$ or better $5a + 4b + 13.5 = 39.75$ or better	B1 B1	$8a - 3b = 18.5$ $5a + 4b = 26.25$

Equates coefficients of either a or b $40a - 15b = 92.5$ $40a + 32b = 210$ or $32a - 12b = 74$ $15a + 12b = 78.75$	M1	or rearranges one of <i>their</i> equations to make a or b the subject e.g. $a = \frac{3b + 18.5}{8}$
Adds or subtracts to eliminate $47b = 117.5$ $47a = 152.75$	M1	Dep on previous method or correctly substitutes into the second equation e.g. $\frac{5(3b + 18.5)}{8} + 4b = 26.25$
$[a =] 3.25$	A1	After M0 scored
$[b =] 2.5$	A1	SC1 for 2 correct values with no working or for two values that satisfy one of their original equations

Question 9

(a) (i) 52 Angles in same segment	1 1dep	Accept same arc, same side of same chord
(ii) 104 Angle at centre is twice angle at circumference	1 1	Accept double, $2 \times$ but not middle, edge
(iii) 34 Angle between tangent and radius $= 90^\circ$	1 1	Accept right angle, perpendicular
(b) (i) 7.65 to 7.651	4	M2 for $8.92 + 72 - 2 \times 8.9 \times 7 \times \cos 56$ or M1 for correct implicit formula and A1 for 58.5 to 58.6
(ii) 49.3 or 49.33 to 49.34...	3	M2 for $[\sin BEC =] \frac{7 \sin 56}{\text{their (b)(i)}}$ oe or M1 for $\frac{\sin 56}{\text{their (b)(i)}} = \frac{\sin BEC}{7}$ oe

Question 10

(a)	100 nfw	4	<p>M3 for a correct calculation that would lead to the answer or B2 two correct relevant different size angles in <i>their</i> diagram or one relevant angle and total in <i>their</i> polygon or angle $EDA + \text{angle } FAD = 140$ or B1 for one relevant angle or total in <i>their</i> polygon</p>
(b) (i)	50	2	<p>B1 for angle $ADC = 80$ or angle $BAC = 30$ or angle $ADB = 50$ soi</p>
(ii)	41	2FT	<p>FT 91 – <i>their</i> (b)(i) B1 for angle $XBC = 41$</p>
(iii)	Similar	1	
(c)	27.8 or 27.83	2	<p>M1 for evidence of $\left(\frac{11}{10}\right)^2$ or 1.21 or $\left(\frac{10}{11}\right)^2$ or 0.826(4...)</p>
(d) (i)	60	3	<p>M2 for $\frac{n}{10} = \frac{360}{n}$ oe e.g. $\frac{180(n-2)}{n} = 180 - \frac{n}{10}$ or B1 for exterior sum = 360 or $180(n-2)$ seen</p>
(ii)	174	2	<p>M1 for $\frac{\text{their } n}{10}$ or $\frac{360}{\text{their } n}$ for <i>their</i> $n < 1800$</p>

Question 11

(a) (i)	66	1	
(ii)	24	1FT	FT 90 – their (a)(i)
(iii)	66	2FT	FT 90 – their (a)(ii) M1 for [$BOD =$] $180 - 48$ or $180 - 2 \times$ their (a)(ii)
(iv)	114	1FT	FT 180 – their (a)(iii)
(b)	83.6 or 83.60[...]	2	M1 for $\frac{1}{2} \times 15 \times 15 \times \sin(180 - 48)$ oe or $\frac{1}{2} \times 15 \times 15 \times \sin(180 - 2 \times$ their (a)(ii)) oe
(c)	Opposite angles add up to 180 OR Angle in a semicircle [=90]	1	

Question 12

(i)	42	2	B1 for $BAC = 90 - 48$
(ii)	111	2	B1 for 111 or 69 or $ACD = 27$ correctly placed on diagram or indicated

Question 13

(a) (i)	Angle A is common to both triangles oe $ADB = ABC$ Third angle of triangles equal oe	1	Accept $DAB = CAB$ oe
(ii)	Similar	1dep	Dep on previous mark
(iii)	8.25	1	
(b) (i)	38	2	M1 for $\frac{16}{12} = \frac{11}{BD}$ oe or better
(ii)	38	1	
(iii)	78	1	
(iv)	26	1	

(c)	36 nfw	5	B4 for an equation in m that simplifies to $5m = 180$ or B1 for each of 3 of the listed angles expressed in terms of m , in it's simplest form, stated or labelled on diagram Angle $PQO = m$ Angle $QOR = m$ Angle $OQR = 2m$ Angle $PQR = 3m$ or $180 - 2m$ or $90 + \frac{m}{2}$ Angle $POR = 180 - m$ or $4m$ or $360 - 6m$ Reflex angle $POR = 360 - 4m$ or $6m$ or $180 + m$
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Question 14

(a) (i)	43	1	
(ii)	62	1	
	Isosceles triangle or OYZ is isosceles	1	
	Angle at centre is twice angle at circumference	1	
(iii)	30	2	M1 for $p + 5p = 180$ oe
	[Opposite angles of a]cyclic quadrilateral [add up to 180°]	1	
(b) (i)	1 : 2 oe	1	
(ii)	OQ	1	
	$MQ = NQ$	1	
	$OM = ON$	1	
	Centre or O	1	Not origin

Question 15

(a)	37 or [angle] BAD [Angles in] same segment [are equal]	1	Dependent on 37 or [angle] BAD
(b)	74 or 2 [\times angle] BAD or 2 [\times angle] BED Angle at <u>centre</u> is twice angle at <u>circumference</u>	1	Dependent on 2×37 or 2 [\times angle] BAD or 2 [\times angle] BED Must use the terms circumference, centre and angle
(c)	143 or $180 -$ [angle] BAD or $180 -$ [angle] BED [Opposite angles of] cyclic quad [are supplementary]	1	Dependent on $180 - 37$ or $180 -$ [angle] BAD or $180 -$ [angle] BED

Question 16

(a)	[$u =$] 80 [$v =$] 160	1	1
(b)	6.24 or 6.244 to 6.245	3	M2 for $\sqrt{8^2 - 5^2}$ oe or M1 for $l^2 + 5^2 = 8^2$ oe or B1 for suitable right angled triangle drawn with 5 on correct side
(c)	5.05 or 5.052....	2	M1 for $\frac{4.8}{2.5} = \frac{9.7}{MN}$ oe
(d)	4 nfw	4	M3 for $[x^n](x+1) = 4 \times \frac{5}{12} [x^n](x-1)$ oe, $n = 1, 2$ or 3

Question 17

(a) (i)	$(6 - 2) \times 180$ or $(2 \times 6 - 4) \times 90$ or $(360 \div 6)$	M1	dep on previous M1
(ii)	$(6 - 2) \times 180 \div 6$ or $(2 \times 6 - 4) \times 90 \div 6$ or $180 - (360 \div 6)$ $1.73x$ or $x\sqrt{3}$ oe	3	M2 for $2x \sin 60$ or $2x \cos 30$ oe or for $\sqrt{x^2 + x^2 - 2 \times x \times x \times \cos 120}$ or M1 for $x \sin 60$ or $x \cos 30$ oe or for $x^2 + x^2 - 2 \times x \times x \times \cos 120$

(iii)	$(10 - x)\sin 30$ seen oe $10 + 2((10 - x)\sin 30)$ oe $10 + 10 - x$ or $10 + 2 \times \frac{1}{2} \times (10 - x)$	M1 M1dep A1	 dep on previous M1 with no errors or omissions seen
(b)	12.7 or 12.67 to 12.68.... nfw	4	B3 for 7.32 to 7.33 or M2 for $x = 20 \div (1 + 1.73)$ oe or M1 for $20 - x = \text{their (a)(ii)}$ oe

Question 18

(a) (i)	27	1	
(ii)	3.89 or 3.888 to 3.889	2	M1 for $\frac{7}{EZ} = \frac{9}{5}$ oe
(b)	76 cao	3	B2 for $ABC = 104$ or $AOC = 152$ or $COD = 28$ or $OBA = 52$ and $OBC = 52$ or $BCD = 128$ and $OCB = 52$ or B1 for any one of $OBA, OBC,$ $OCB = 52$ or $BCD = 128$
(c) (i)	90 angle in semicircle	1 1	
(ii)	27 tangent [perpendicular to] radius	1 1	
(iii)	rectangle	1	

Question 19

(a)	38	1	
	118	1	
	62	1FT	FT 180 – their y
(b)	69	3	B2 for $ACB = 42$ or B1 for $ADB = 42$ If zero scored, SC1 for $ACB = \text{their } ADB$
(c)	107	2	B1 for $QPS = 73$ or [reflex] $QOS = 214$

Question 20

(a)	66[.0] or 66.03 to 66.04	2	M1 for $\tan = \frac{9}{4}$ oe
(b)	$\sqrt{3^2 + 4^2}$ or $\frac{1}{2}\sqrt{6^2 + 8^2}$	M1	Any alternative method must be full and complete and result in exactly 5
(c)	60.9 or 60.94 to 60.95	2	M1 for $\tan = \frac{9}{5}$ oe
(d)	5.83 or 5.84 or 5.827 to 5.840	6	<p>M1 for $[PB \text{ or } PC =] \sqrt{9^2 + 5^2}$ or $[XC =] \sqrt{9^2 + 5^2} - 7.5$</p> <p>M1 for angle $BPX = 2 \times \text{invsin} \frac{3}{\text{their } PB}$ oe</p> <p>B1 for $[PB \text{ or } PC =] \sqrt{106} = 10.29$ to 10.30 or $XC = 2.79$ to 2.8[0] or angle $BPX = 33.9$ or 33.86 to 33.90...</p> <p>M2 for $\sqrt{(\text{their } PB)^2 + 7.5^2 - 2 \times \text{their } PB \times 7.5 \times \cos(\text{their } BPX)}$ oe</p> <p>or M1 for correct implicit equation</p>

Question 21

(a)(i)(a)	62 and Isosceles [triangle] and Angle at centre is twice angle at circumference oe	3	<p>B2 for 62 and one correct reason or B1 for 62 with no/wrong reason or for angle $EOD = 124$ soi or for no/wrong angle with correct reason</p>
(a)(i)(b)	62 and [Angles in] same segment oe or angle at centre is twice angle at circumference oe	2	<p>2FT <i>their (a)(i)(a)</i> and correct reason</p> <p>B1FT for <i>their (a)(i)(a)</i> with no/wrong reason or for no/wrong angle with correct reason</p>
(a)(ii)	8	3	<p>M2 for $(180 - 109) - 28 - 35$ oe or M1 for $[\text{angle } AED =] 180 - 109$ oe</p>
(b)(i)	24	3	<p>$x = \text{ext angle}$ B2 for $[x =] 15$ isw or M1 for $x + 11x = 180$ oe or for $\frac{180(n-2)}{[n]} = \frac{360}{[n]} \times 11$</p>

(b)(ii)	3960	2	FT (<i>their</i> $24 - 2$) $\times 180$ dep on (b)(i) an integer and > 6 M1 for (<i>their</i> $24 - 2$) $\times 180$ oe or <i>their</i> $24 \times 11 \times$ <i>their</i> 15 oe or 11×360
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Question 22

(a)	18	3	B2 for 20 nfw or M1 for $8x + x = 180$ or better
(b)	32	3	B1 for angle $DBC = 58$ B1 for angle $BCD = 90$
(c)(i)	24	2	B1 for angle $PRQ = 24$
(c)(ii)	29.4 or 29.40 to 29.41	3	M2 for $\frac{360 - 48}{360} \times 2 \times \pi \times 5.4$ or B2 for answer (minor arc) 4.52 or 4.523 to 4.524... or M1 for $\frac{48}{360} \times 2 \times \pi \times 5.4$

Question 23

(a)	29	1	
(b)	128	2	FT $180 - 2(55 - \text{their (a)})$ M1 for angle OCA or angle $OAC = 55 - \text{their (a)}$ soi
(c)	64	1	FT <i>their (b)</i> $\div 2$
(d)	116	1	FT $180 - \text{their (c)}$

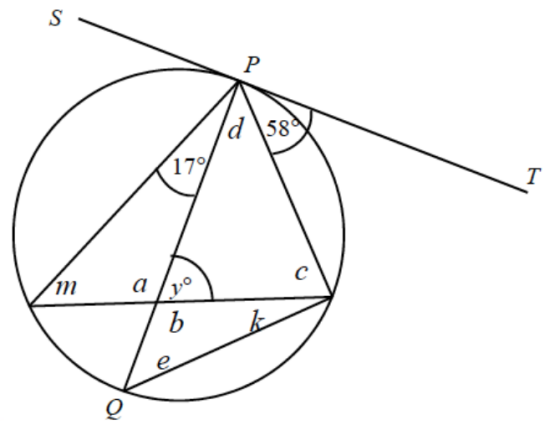
Question 24

(a)	$180 - \frac{360}{5}$ or $\frac{(5-2) \times 180}{5}$ or $\frac{(2 \times 5 - 4) \times 90}{5}$ or $\frac{5 \times 180 - 360}{5}$	M2 or M1 for $\frac{360}{5}$ or $(5-2) \times 180$ or $90(2 \times 5 - 4)$ or $3 \times 180 \div 5$ or $6 \times 90 \div 5$ or $5 \times 180 - 360$ If 0 scored, SC1 for $\frac{5-2 \times 180}{5}$
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(b)(i)	7.05 or 7.053...	3	<p>M2 for $12 \times \cos 54$ oe</p> <p>or M1 for implicit form</p> <p>or B1 for length of edge of pentagon = 14.1 to 14.11</p> <p>If 0 scored, SC1 for right angle at M</p>
(b)(ii)(a)	22.8 or 22.81 to 22.83... nfw	3	<p>M2 for $\frac{\text{their (b)(i)}}{\cos 72}$ oe</p> <p>or M1 for implicit form oe</p> <p>or B1 for $AX = 36.9$ or 36.93 to 36.94</p>
(b)(ii)(b)	179 or 179.1 to 179.3...	3	<p>M2 for $\frac{1}{2} \times 12 \times \text{their } AX \times \sin 54$ oe</p> <p>or $\frac{1}{2} \times 12 \times \text{their } OX \times \sin 108$ oe</p> <p>or $\frac{1}{2} \times \text{their } AX \times \text{their } OX \times \sin 18$</p> <p>or $\frac{1}{2} \times 12^2 \times \sin 72 + \text{area } OBX$ oe</p> <p>or</p> <p>$\frac{1}{2} \times 12^2 \times \sin 72 + \text{area } OMB + \text{area } MBX$ oe</p> <p>or M1 for a correct method to find area of one relevant triangle AOB, OMB, MBX, OBX or ONX seen</p>

Question 25

(a)	103	3	<p>M1 for angle ABC or angle $ACB = \frac{1}{2}(180 - 26)$ oe</p> <p>M1 for angle $ABF = 26$</p> <p>or angle CBD or angle $FBE = 77$ or exterior angle $ACB = 103$ correctly identified or in correct position</p>
(b)	75	5	<p>B4 for 105 at a or b</p> <p>or 73 at c and 32 at d</p> <p>or B3 for 58 at m</p> <p>or 58 at e and 17 at k</p> <p>or B2 for 32 at d and 90 soi at $(c+k)$</p> <p>or 32 at d and 17 at k</p> <p>or 73 at c</p> <p>or B1 for 90 soi at $(c + k)$ or between tangent and radius</p> <p>or 32 at d or 17 at k</p>



Question 26

(i)	Angle $ABC=52$ nfww	B1	ALTERNATIVE [Reflex] angle $AOC = 256$
	Opposite angles in cyclic quad oe Angles in opposite segments	B1	Angle at centre = $2 \times$ angle at circumference/arc
	[Angle $AOC=104$] Angle at centre = $2 \times$ angle at circumference/arc nfww	B1	Angles around a point
(ii)	22 nfww	2	B1 for angle $OAC = 38$ or angle $CAD = 24$
(iii)	28	1	
(iv)	36.6 or 36.62 to 36.63 nfww	3	B2 for 7.4 or 17.42 to 17.43 or M2 for $9.6 \times 2 + \frac{104}{360} \times 2 \times \pi \times 9.6$ or M1 for $\frac{104}{360} \times 2 \times \pi \times 9.6$

Question 27

(a)(i)	$2a + a + 2b + 3b + 10 = 180$ leading to $3a + 5b = 170$ without error or omission	1	
(a)(ii)	$8a + 3a + 2b + b + 50 + 4b - 2a = 360$ leading to $9a + 7b = 310$ without error or omission	1	
(a)(iii)	Correct method to eliminate one variable	M1	
	$[a=]15$ $[b=]25$	A2	A1 for each correct value If 0 scored, SC1 for two values that satisfy one of the equations or for two correct answers with no/incorrect working
(a)(iv)	30	1	
(b)	-1.5 or $-1\frac{1}{2}$ or $-\frac{3}{2}$	2	M1 for $6x = -12 + 3$ or better
(c)	$\frac{3x+3}{2}$ oe final answer	3	M1 for $8x - 2y = 5x - 3$ or $4x - y = \frac{1}{2}(5x - 3)$ M1FT for isolating the y term correctly
(d)	$9x^6$	2	M1 for $(3x^3)^2$ or $(729x^{18})^{\frac{1}{3}}$ seen or for $9x^k$ or kx^6 as final answer
(e)	$\frac{x}{x-5}$ final answer nfw	3	M1 for $x(x+5)$ M1 for $(x-5)(x+5)$

Question 28

(a)	$[p =] 132$ $[q =] 77$	3	B1 for $132 [=p]$ B2 for $77 [=q]$ or M1 for $180 - (55 + 48)$ oe or for <i>their</i> $p - 55$
(b)	74	3	B2 for $5x - 10 = 360$ or M1 for $x + (x + 5) + (2x - 25) + (x + 10) = 360$ or for $5x - 10 = k$
(c)	175	3	M2 for $180 - \frac{360}{72}$ or for $\frac{180(72 - 2)}{72}$ or M1 for $\frac{360}{72}$ or for $180 (72 - 2)$
(d)	$[u =] 30$ $[v =] 60$ $[w =] 60$ $[x =] 120$ $[y =] 40$	6	B1 for 30 B1 for 60 B1 for 60 FT <i>their v</i> B1 for 120 FT $2 \times$ <i>their w</i> B2 for 40 or B1 for angle $BDC = 20$ or angle $ADO = 30$ or angle $ADB = 70$
(e)	26	4	B3 for $360 - 22 = 10x + 3x$ oe or better or for $5x + 1.5x = 180 - 11$ oe or better or M2 for $360 - (3x + 22) = 2 \times 5x$ oe or for $5x + \frac{1}{2}(3x + 22) = 180$ oe or SC2 for $360 + 22 = 10x + 3x$ oe or better or M1 for $180 - 5x, 10x$ or $360 - (3x + 22)$ correctly placed on the diagram or identified or for angle $A +$ angle $C = 5x$

Question 29

(a)	12	2	M1 for $150 = \frac{(n-2) \times 180}{n}$ or $\frac{360}{180-150}$ oe
(b)(i)	45	2	B1 for angles at M or $K = 45$ or angle at $L = 90$
(b)(ii)	85	2	B1 for either angle in alt segment = 58
(b)(iii)	72	2	B1 for either angle at J or $H = 108$ or angle at $F = 72$
(c)	$OA = OB = OC = OD$ Radii	B1	
	$AB = CD$ chords equidistant from centre are equal	B1	
	SSS implies congruent	B1	

Question 30

(a)(i)	36	2	M1 for $\left(\frac{8}{12}\right)^2$ or $\left(\frac{12}{8}\right)^2$ oe
(a)(ii)	30	3	M2 for $320 \div 16 \times \frac{12}{8}$ oe or M1 for $320 \div 16$
(b)	3.375 cao	3	M2 for $\frac{\frac{4}{3}\pi \times 4.5^3}{\pi \times 6^2}$ or better or M1 for $\pi \times 6^2 \times h = \frac{4}{3}\pi \times 4.5^3$
(c)	3.63 or 3.627 to 3.628	3	M2 for $\frac{20^3}{40 \times \frac{4}{3}\pi}$ or M1 for $40 \times \frac{4}{3}\pi \times r^3 = 20^3$
(d)	$\frac{3x}{2}$ or $1.5x$ or $1\frac{1}{2}x$	3	B2 for $4R^2 = 9x^2$ oe or better or M1 for $4\pi R^2 = 2\pi x^2 + \pi \times 2x \times \frac{7x}{2}$

Question 31

(a)(i)	81° <u>Angle at centre is twice angle at circumference</u> oe	2	B1 for 81°
(a)(ii)	81° Alternate segment [theorem] oe	2	FT <i>their (a)(i)</i> B1FT for 81°
(a)(iii)	123° <u>Angles on a straight line</u> [= 180] Opposite angles in a <u>cyclic quadrilateral</u> are supplementary oe	3	FT <i>their acute (a)(ii)</i> + 42 B1 for each element
5(b)(i)	Angle $PTU =$ angle PRQ corresponding Angle $PUT =$ angle PQR corresponding Angle RPQ is common oe	M2	Accept in any order M1 for one correct pair with reason If 0 scored, SC1 for two correct pairs of equal angles identified with incorrect/no reasons
	Corresponding angles are equal oe	A1	
(b)(ii)(a)	4 : 7 oe	1	
(b)(ii)(b)	41.25 oe	3	M2 for $20 \times \left(\frac{7}{4}\right)^2$ oe or $20 \times \frac{7^2 - 4^2}{4^2}$ oe or M1 for $\left(\frac{7}{4}\right)^2$ or $\left(\frac{4}{7}\right)^2$ or $\frac{7^2 - 4^2}{4^2}$ or $\frac{4^2}{7^2 - 4^2}$

Question 32

(a)	[v =] 40 [w =] 80 [x =] 40 [y =] 100 [z =] 60	5	B1 for each FT angle z as $140 - \textit{their w}$
(b)	24	3	M2 for $360 - 11x = 2 \times 2x$ oe or M1 for $360 - 11x$ seen or obtuse angle $KOL = 2 \times 2x$ oe

(c)(i)	angle $ADX = angle BCX$ oe same segment oe angle $DAX = angle CBX$ oe same segment oe angle $AXD = BXC$ oe [vertically] opposite oe	M2	Accept in any order M1 for one correct pair with reason If 0 scored, SC1 for two correct pairs of equal angles identified with incorrect/no reasons
	corresponding angles are equal oe	A1	
(c)(ii)(a)	8.75 or $8\frac{3}{4}$	2	M1 for $\frac{8}{10} = \frac{7}{DX}$ oe
(c)(ii)(b)	81.8 or 81.78 to 81.79	4	M2 for $[\cos[BXC] =] \frac{5^2 + 7^2 - 8^2}{2 \times 5 \times 7}$ oe or M1 for $8^2 = 5^2 + 7^2 - 2 \times 5 \times 7 \times \cos(\dots)$ oe A1 for $\frac{10}{70}$ oe

Question 33

(a)	38.6	3	M2 for $[2 \times] (8.5 + 0.05 + 10.7 + 0.05)$ or M1 for $8.5 + 0.05$ or $10.7 + 0.05$
(b)(i)	8.86 or 8.863...	2	M1 for $\frac{h}{9} = \sin 80$ or better oe
(b)(ii)	$\angle CDF = 100$ leading to $\angle DCF = 40$ Or $\angle EDF = 80$ leading to $\angle DCF = 40$	M1	Implied by $180 - (100 + 40) = 40$ or $80 - 40$
	'two equal angles'	A1	With no incorrect work seen
(b)(iii)	66.5 or 66.45 to 66.47...	3	M2 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 B1 for $DC = 9$ or $BC = 3$

(c)	130 nfw or 129.6 to 129.8	5	B1 for $\angle ACD = 21^\circ$ or $\angle CAD = 69^\circ$ Method 1 M2 for $\cos 21 = \frac{12}{AC}$ oe or M1 for $\angle ADC = 90$ soi M1 for $\pi(\text{their } AC/2)^2$ OR Method 2 M2 for $\frac{12}{\sin 138} = \frac{r}{\sin 21}$ oe or M1 for $\angle COD = 138$ soi M1 for $\pi(\text{their } r)^2$
(d)	78.4 or 78.37 to 78.41	3	M2 for $\frac{x}{360} \times 2 \times \pi \times 9.5 + 2 \times 9.5 = 4 \times 8$ oe or M1 for $\frac{x}{360} \times 2 \times \pi \times 9.5$ After M0, SC1 for $9.5x + 19 = 32$ oe
Question 34			
(a)	1600	3	B2 for answer figs 16 or M2 for $90.72 \div (\text{figs}45 \times \text{figs}3 \times \text{figs}42)$ or M1 for volume = figs 45 \times figs 3 \times figs 42 isw
(b)	62.8 or 62.83 to 62.84	3	M2 for $\frac{\pi \times 10^2 \times 30}{15000} \times 100$ or M1 for $\pi \times 10^2 \times 30$
(c)	12.9[0]	3	B2 for 86 OR M2 for $\frac{98.9}{1 + \frac{15}{100}} \times 0.15$ oe or $98.9 - \frac{98.9}{1 + \frac{15}{100}}$ oe or M1 for $\left(1 + \frac{15}{100}\right)^a = 98.9$ oe isw
(d)	50	2	M1 for $3540 \div 70.8$

Question 35

(a)	126 54 117	3	B1 for each
(b)	angle [in a] semicircle is 90	B1	Do not accept triangle for angle
	Allied, co-interior [add to 180] or Angles in triangle [= 180] and alternate oe	B1	
	32	B1	
(c)	109	2	B1 for 218 or 71 in correct places or correctly labelled

Question 36

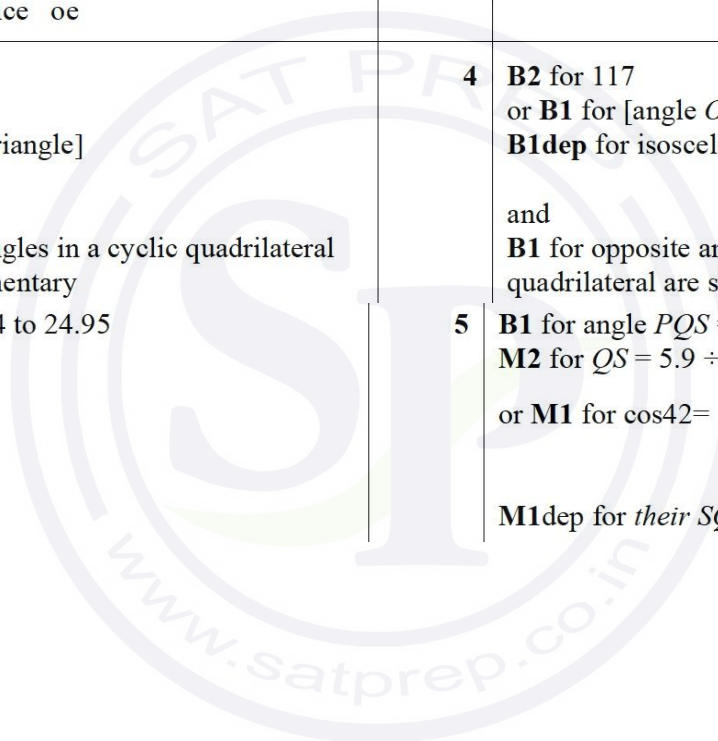
(a)	20	2	M1 for $\frac{360}{18}$ or $180 - \frac{16 \times 180}{18}$
(b)	4.5	2	M1 for $\frac{BE}{6.75} = \frac{5.2}{5.2 + 2.6}$ oe
(c)	5.8[0] or 5.798 to 5.799	3	M2 for $2 \times \sqrt[3]{\frac{780}{32}}$ oe or M1 for $\sqrt[3]{\frac{780}{32}}$ or $\sqrt[3]{\frac{32}{780}}$ or $\frac{2^3}{l^3} = \frac{32}{780}$
(d)	$QN = NR$ [given]	B1	
	Two correct pairs of angles with reasons from angle $PQN =$ angle SRN alternate angle $QPN =$ angle RSN alternate angle $PNQ =$ angle SNR [vertically] opposite	B2	B1 for any correct pair of angles with reason or two correct pairs of angles with no/wrong reasons
	ASA [implies congruent]	B1	dep on B1 B2

Question 37

2(a)	52°	3	M1 for $180 - 2 \times 38$, implied by 104 M1 for <i>their</i> $AOB \div 2$
b)(i)	80°	2	B1 for $FEC = 50$ or $FCE = 50$
b)(ii)	100°	1	FT 180 – <i>their</i> (i)

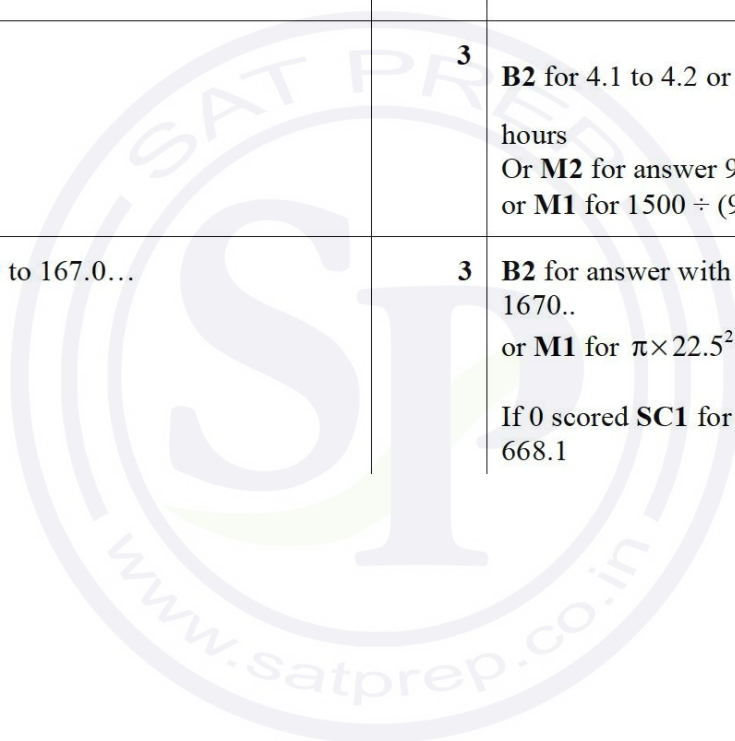
Question 38

(a)(i)	62 and Angle at centre is twice angle at circumference oe	2	B1 for either
(a)(ii)	117 and Isosceles [triangle] and Opposite angles in a cyclic quadrilateral are supplementary	4	B2 for 117 or B1 for [angle $OCD =$] 28 B1dep for isosceles [triangle] and B1 for opposite angles in a cyclic quadrilateral are supplementary
(b)	24.9 or 24.94 to 24.95	5	B1 for angle $PQS = 42$ M2 for $QS = 5.9 \div \cos 42$ oe or M1 for $\cos 42 = \frac{5.9}{QS}$ oe M1dep for <i>their</i> $SQ \times \pi$ oe



Question 39

(a)(i)	683	3	M2 for $[2]((19.4 \times 9.2) + (5.7 \times 9.2) + (19.4 \times 5.7))$ oe or M1 for one of 19.4×9.2 or 5.7×9.2 or 19.4×5.7
(a)(ii)	1.93[0] or 1.932 to 1.933	3	M2 for $19.4 \times 9.2 \times 5.7 \times 1.9$ or M1 for $19.4 \times 9.2 \times 5.7$
(b)	39 375	3	M2 for $9000 \div 200 \times 175 \times 5$ or M1 for $9000 \div 200$ soi or for $\frac{175}{200}$ soi
(c)	10 th July	3	B2 for 4.1 to 4.2 or $4\frac{1}{6}$ or 4 days 1.5 hours Or M2 for answer 9 th July or 11 th July or M1 for $1500 \div (9 \times 40)$
(d)	167 or 166.9 to 167.0...	3	B2 for answer with figs 167 or figs 1669 to 1670.. or M1 for $\pi \times 22.5^2 \times 105$ oe If 0 scored SC1 for answer 668 or 667.9 to 668.1



Question 40

(a)	15	2	M1 for $\frac{360}{180-156}$ or for $\frac{180(n-2)}{n} = 156$ oe
(b)	38	2	B1 for $AOB = 76$
(c)	68	2	B1 for $RSP = 68$ or $RQP = 112$
(d)	Two pairs of equal angles identified with fully correct reasons	M3	<p>M2 for one pair of equal angles identified with fully correct reasons</p> <p>$KMG = 90$ angle in semicircle and $OGH = 90$ angle between tangent and radius</p> <p>OR</p> <p>$KMG = OGH$ alternate segment</p> <p>OR</p> <p>$GOH = MGK$ alternate angles</p> <p>OR</p> <p>Angle $FGM =$ angle GHO corresponding and angle $FGM = GKM$ alternate segment and angle $H =$ angle K</p> <p>or M1 for $KMG = 90$, angle in semicircle or $OGH = 90$, angle between tangent and radius</p>
	Two or three pairs of angles equal [so similar] oe	A1	Dep on M3 with no incorrect work seen

Question 41

(a)	$\frac{(12-2) \times 180}{12} [= 150] \text{ oe}$ or $180 - \frac{360}{12} [= 150]$	1	Accept $\frac{(2 \times 12 - 4) \times 90}{12} [= 150]$
(b)(i)	$\frac{3}{\cos 75} \text{ oe}$ or $\frac{6 \sin 75}{\sin 30}$	M2	M1 for $\frac{3}{AO} = \cos 75 \text{ oe}$ or $\frac{r}{\sin 75} = \frac{6}{\sin 30}$
	11.59...	A1	
(b)(ii)(a)	72.8 or 72.9 or 72.82 to 72.89...	2	M1 for $2 \times \pi \times 11.6$
(b)(ii)(b)	12.1 or 12.06 to 12.08	2	M1 for $[6 +] \text{ their (b)(ii)(a)} \div 12 \text{ oe}$
(c)	806 or 807 or 805.9 to 807.4	3	B2 for 402.9... to 403.7 OR M2 for $\frac{1}{2} \times 6 \times 11.6 \times \sin 75 \times 12 \times 2 \text{ oe}$ or M1 for $\frac{1}{2} \times 6 \times 11.6 \times \sin 75 [\times k] \text{ oe}$

Question 42

(a)	$PMR = MSR = \text{right angle[s] or } 90^\circ$	B1	
	$PRM = MRS \text{ same angle}$	B1	
	AAA oe	B1	Dep on B1B1 and no errors seen
	OR $MPR = SMR \text{ 3rd angle of triangle}$		
(b)(i)	5.5	2	M1 for $\frac{x}{4.5} = \frac{9.9}{8.1} \text{ oe}$
(b)(ii)	16.7 or 16.73 to 16.74	2	M1 for $25 \times \left(\frac{8.1}{9.9}\right)^2 \text{ oe}$ or $25 \times \left(\frac{4.5}{\text{their } 5.5}\right)^2 \text{ oe}$

Question 43

(a)	$PQR = 90$ angle in semi-circle	B1	
	$PRQ = 61$ angle sum of triangle [= 180]	B1	
	$PSQ = 61$ angle in same segment	B1	If 0 scored SC1 for $PSQ = PRQ$ [= 61] soi
(b)	57	4	B1 for $ABT = 98$ B1 for TAB or $ATB = 41$ B1 for $BTC = 41$ or $TBC = 82$ or $ATC = 82$ soi

Question 44

(a)	$[\cos B =] \frac{9.5^2 + 7.7^2 - 10^2}{2 \times 9.5 \times 7.7}$ oe	M2	M1 for $10^2 = 9.5^2 + 7.7^2 - 2 \times 9.5 \times 7.7 \cos B$ oe or better
	70.206 to 70.207 or 70.21 to 70.22	A2	A1 for $\frac{2477}{7315}$ oe or 0.339 or 0.3386....
(b)(i)	140.4	1	
(b)(ii)	19.8	1	FT (180 – their (b)(i)) ÷ 2
(b)(iii)	70.2	1	FT 90 – their (b)(ii)
(c)	5.31 or 5.314 to 5.315	3	M2 for $\frac{5}{\cos \text{their (b)(ii)}}$ oe or M1 for $\frac{5}{r} = \cos(\text{their (b)(ii)})$ oe
(d)	38.8 or 38.9 or 38.78 to 38.85	4	M3 for $\frac{0.5 \times 9.5 \times 7.7 \times \sin 70.2}{\pi \times (\text{their (c)})^2}$ [×100] OR M1 for $0.5 \times 9.5 \times 7.7 \times \sin 70.2$ M1 for $\pi \times (\text{their (c)})^2$

Question 45

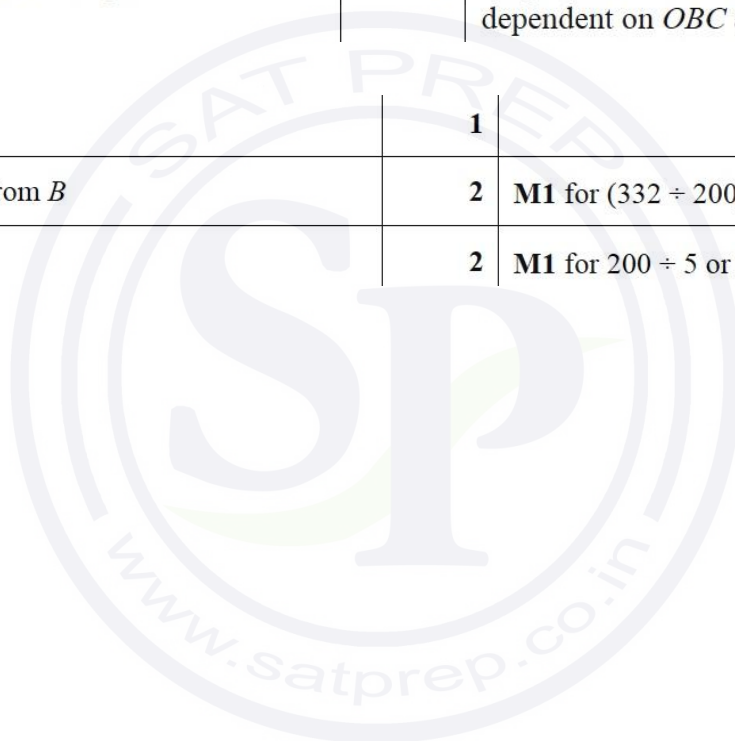
(i)	58	1	
(ii)	106	1	
(iii)	47	2	B1 for $PRQ = 27$ or B1FT for SPR , either = 48 or = 106 – their (b)(i) or B1FT for $RPQ = \text{their (b)(i)} - 11$

Question 46

Radius perpendicular to tangent	1	
Tangents to circle from a/same point oe	1	
RHS	1	
68 angles on a [straight] line add up/sum to 180 oe	1	
56 [base angles of] isosceles triangle	1	
$OBC = BOT$ Alternate angles	1	Angles and reason required and dependent on OBC and BOT correct

Question 47

(i)	118	1	
(ii)	X is 8.3 cm from B	2	M1 for $(332 \div 200) \times 5$ oe
(iii)	1 : 4000	2	M1 for $200 \div 5$ or 200×100 , both soi



Question 48

(a)	111	3	<p>M2 for $180 - \frac{180-42}{2}$ oe or $42 + \frac{180-42}{2}$ oe</p> <p>or M1 for $\frac{180-42}{2}$ oe</p>
(b)	150	3	<p>M1 for $k \div (3 + 4 + 5)$ [$\times p$] where $p = 1, 3, 4$ or 5</p> <p>or $\frac{5}{12}$ oe</p> <p>B1 for 360 used</p>
(c)	$\frac{3}{5}$ cao nfw	4	<p>B3 for $\frac{72}{120}$</p> <p>or B2 for $[d =] 72$ or $[h =] 120$</p> <p>or M1 for $360 \div 5$ oe isw</p> <p>or $180 - (360 \div 6)$ isw</p> <p>or for $(6 - 2) \times 180$ [$\div 6$]</p>
(d)	$x + 2x - 5 + x + 20 + 3x - 40 = 360$	M1	Accept equivalent equation e.g. $7x - 25 = 360$
	$7x = 360 + 5 - 20 + 40$ or better	M1	FT <i>their</i> equation, accept e.g. $7x = 385$
	$x = 55$	B1	
	55 and 125 or 105 and 75	B1dep	Dep on M1M1B1 Accept $55 + 3 \times 55 - 40 = 180$ or $2 \times 55 - 5 + 55 + 20 = 180$ If B0 scored, SC1 for 55, 75, 105 and 125
	Opposite angles sum to 180 oe [so PQRS is a cyclic quadrilateral]	A1	Dep on M1M1B1B1
(e)	48.7 or 48.69 to 48.70...	3	<p>M2 for $\frac{360-50}{360} \times 2 \times \pi \times 9$ oe</p> <p>or M1 for $\frac{50}{360} \times 2 \times \pi \times 9$ oe</p>