Extended Mathematics
Topic :Trigonometry
Year :May 2013 -May 2024
Paper -4
Answers

Question 1

(a)	**(i)**	$\frac{12^2+21^2-15^2}{2\times12\times21}$ 44.41 to 44.42	**M2** **A2**	**M1** for $15^2 = 12^2 + 21^2$ - 2.12.21cos$M$ **A1** for [cos =] 0.714 or 0.7142 to 0.7143 or $\frac{360}{504}$ oe
	(ii)	88.2 or 88.15 to 88.19	**2**	**M1** for 0.5 × 12 × 21 × sin (44.4) oe
(b)		7.74 or 7.736 to 7.737…. www	**4**	**B1** for 55 soi **M2** $\frac{6.4}{\sin(their\ R)}\times\sin 82$ oe **or M1** for $\frac{6.4}{\sin(their R)}=\frac{PR}{\sin 82}$ oe

Question 2

(i)	59.6 or 59.57… www	4	**M2** for $45^2+32^2-2\times45\times32\times\cos100$ **or M1** for implicit cos rule **and A1** for 3549….
(ii)	22.[0] or 21.99… www	3	**M2** for 324 ÷ (½ × 32 × sin67) **or M1** for [324 =] ½ × 32 × x × sin67

Question 3

6.61 (6.614…)	www	**6**	**B1** for $\frac{x+2}{2x+3} = \frac{9}{16}$ oe **M1** for $16(x + 2) = 9(2x + 3)$ or better **A1** for $[x =] 2.5$ **M2** for $\sqrt{\{(2 \times \textit{their}\ x + 3)^2 - (\textit{their}\ x + 2)^2\}}$ or **M1** for $(2 \times \textit{their}\ x + 3)^2 - (\textit{their}\ x + 2)^2$ or **SC2** for final answer of $4\sqrt{13}$ or $\frac{7\sqrt{15}}{2}$ or better

Question 4

(a)	119.94[…] nfww	**3**	**M2** for $\frac{62 \times \sin 122}{\sin 26}$ or **M1** for $\frac{AC}{\sin 122} = \frac{62}{\sin 26}$ oe **SC2** for correct answer from alternative methods
(b)	109 or 108.7 to 108.8 nfww	**4**	**M2** for $119.9..^2 + 55^2 - 2 \times 119.9.. \times 55\cos 65$ **A1** for 11827[·…] or 11834 to 11835[·…] or **M1** for implicit version
(c)	1970 or 1969 to 1970.4	**2**	**M1** for ½ × 119.9.. × 62 × sin 32
(d)	22300 or 22310 to 22320	**3**	**M2** for (*their* (c) + 0.5 × 55 × 119.9.. × sin65) × 4.5 or **M1** for *their* (c) + 0.5 × 55 × 119.9.. × sin65

Question 5

(a)	36.9° or 36.86 to 36.87	**2**	**M1** for tan[*DBC*] = 1.8/2.4 oe
(b)	**(i)** $1.8^2 + 2.4^2$ leading to $\sqrt{9}$	**2**	**M1** for $1.8^2 + 2.4^2$ or better
	(ii) [cos*ABD*) =] $\frac{6.46^2 + 3^2 - 8.6^2}{2 \times 6.46 \times 3}$	**M2**	**M1** for correct cos rule but implicit version
	127 or 126.8…	**A2**	**A1** for –0.599…
			After **0** scored, **SC2** nfww for answer 127 or 126.8 to 126.96 from other methods or no working shown
(c)	39.6 or 39.7 or 39.59 to 39.68	**3**	**M2** for ½ (2.4 + 8.6) × 1.8 × 4 oe **Or M1** for $\frac{1.8}{2}(2.4+8.6)$ oe soi by 9.9 to 9.92

Question 6

(a)	45.[0] or 45.01 to 45.02 nfww	**4**	**M2** for $55^2 + 70^2 - 2.55.70 \cos 40$ or **M1** for correct implicit equation **A1** for 2026. ….
(b)	84.9 or 84.90 to 84.92	**4**	**B1** for angle BDC = 40 soi **M2** for $\frac{70\sin(\textit{their}\,40)}{\sin 32}$ or M1 for correct implicit equation
(c)	**(i)** 4060 or 4063 to 4064 nfww	**3**	**M2** for $\frac{1}{2}(55 \times 70 \sin 40) + \frac{1}{2}(70 \times \textit{their}(b) \sin(180 - \textit{their}\,40 - 32))$ oe or **M1** for correct method for one of the triangle areas
	(ii) 1020 or 1015 to 1016	**2FT**	**FT** *their* **(c) (i)** ÷ 4 oe correctly evaluated or **M1** *their* **(c) (i)** ÷ figs 4 oe

(ii) 1020 or 1015 to 1016	**2FT**	**FT** *their* **(c) (i)** ÷ 4 oe correctly evaluated or **M1** *their* **(c) (i)** ÷ figs 4 oe
(d) 35.4 or 35.35… nfww	**2**	**M1** for $\sin 40 = \frac{distance}{55}$ or better or for $\frac{1}{2}(55 \times 70 \sin 40) = (70 \times \text{distance}) \div 2$

Question 7

(a) (i)	72[.0] or 71.98 to 71.99 nfww	**3**	**M2** for [sin P =] $\frac{97}{\frac{1}{2}\times 12\times 17}$ oe **or M1** for implicit version
(ii)	16.2 or 16.18 to 16.19 nfww	**4**	**M2** for $6^2 + 17^2 - 2\times 6\times 17\times\cos(\textit{their}\ 72)$ **or M1** for implicit form **and A1** for [XR^2 =] 261.8 to 262
(b)	7.61 or 7.612... nfww	**4**	**M3** for [a =] 9.4 × sin 37 ÷ cos 42 oe or [a =] 9.4sin37/sin(90–42) **or M2** for [a =] their height ÷ cos 42 oe or $\frac{a}{\sin 37} = \frac{9.4}{\sin(90-42)}$ oe **or M1** for their height ÷ a = cos 42 or for [their height =] 9.4 × sin 37 oe **or B1** for 48° correctly used or seen in correct position on diagram
(c)	50	**1**	
	130	**1**	

Question 8

(a)	86.8 or 86.83….	**3**	**M2** for $\frac{80\sin 55}{\sin 49}$ or **M1** for $\frac{80}{\sin 49}=\frac{x}{\sin 55}$ oe
(b)	51.2 or 51.15 to 51.16	**4**	**M2** for [cos =] $\frac{95^2+90^2-80^2}{2.95.90}$ oe **or M1** for $80^2=95^2+90^2-2.90.95.\cos BCD$ **A1** for $\frac{10\,725}{17\,100}$ or $\frac{143}{228}$ etc. or 0.627…..
(c)	6700 or 6698 to 6703	**3**	**M2** for 0.5 × 80 × *their*(a) × sin(180-55-49) oe [3368 – 3370…] [If *AB* used then *AB*= 102.8 to 103] + 0.5 × 90 × 95 × sin(*their*(b)) oe [3329 – 3332] **or M1** for one of these triangle area methods oe
(d)	2180 or 2176 to 2179	**3FT**	**FT** *their* (c) × 0.325 correctly evaluated to 3 sf or better **M2** for *their* (c) × $\frac{3250}{10\,000}$ **or SC1 FT** for figs 218 or figs 2176 to 2179

Question 9

(a)	[0]44 to [0]48	**1**	
(b)	12.6 to 13.2	**2**	**B1** for 8.4 to 8.8 seen
(c)	340	**1**	
(d)	1 : 150000	**2**	**M1** for × 100000 soi

Question 10

(a)	Angle $LPQ = 32$ soi $58^2 + 74^2 - 2 \times 58 \times 74 \cos \textit{their } P$	**B1** **M2**	**M1** for correct implicit cos rule
	39.50[1...]	**A2**	**A1** for 1560.3 to 1560.4 or 1560
(b)	$\sin PQL = \frac{58 \sin \textit{their } P}{39.5}$ oe	**M2**	**M1** for $\frac{\sin PQL}{58} = \frac{\sin(\textit{their } P)}{39.5}$ oe
	51.1 or 51.08 to 51.09	**B1**	
(c) (i)	322	**2**	**M1** for 180 + 142 oe
(ii)	[0]13[.1] or 13.08 to 13.09	**1FT**	**FT** *their* **(b)** – 38
(d)	17.8 or 17.77 to 17.78	**3**	**M1** for 74 ÷ 2.25 oe soi by 32.888… to 3 sf or better **M1** for dist or speed ÷ 1.85
(e)	30.7 or 30.73 to 30.74…	**3**	**M2** for 58 sin *their P* oe or 39.5 sin *their* **(b)** or **M1** for $\frac{x}{58} = \sin \textit{their } P$ oe or $\frac{x}{39.5} = \sin \textit{their}$ **(b)**

Question 11

(a)	$\frac{1}{2} \times 16 \times 5.4 \times \sin 62$ oe	**M1**	
	38.14...	**A1**	
(b)	95.6 or 95.64 to 95.65	**4**	**M2** for $\frac{6.7 \times \sin 48}{8.4}$ **or M1** for implicit form **and M1dep** for 180 – 48 – *their* 36.4

(c)	286 or 285.7 to 285.8	**5**	**B1** for [Angle APB=] 83° **M2** for $180^2 + 245^2 - 2\times180\times245\times\cos$ *their* 83 **or M1** for implicit form **and A1** for [AB^2 =] 81676[.1...] After 0 scored, **SC2** for ans 406.87 to 406.88 or 406.9 or 407 if 146° used in cos rule Or **SC1** for $180^2 + 245^2 - 2\times180\times245\times\cos 146$

Question 12

(a)	$95.5^2 + 83.1^2 - 2 \times 95.5 \times 83.1 \times \cos 101$	**M2**	**M1** for $\cos 101 = \dfrac{95.5^2 + 83.1^2 - AB^2}{2\times95.5\times83.1}$
	138.0…	**A2**	**A1** for 19054.[…] also implies **M2**
(b)	110 or 109.7 to 109.8	**4**	**B3** for 36.2 or 36.20 to 36.24[1..]
(c)	18.8 or 18.79[…]	**2**	**M1** for 46.2 × cos(45 + 21) oe After **M0**, **SC1** for answer 42.2 or 42.20 to 42.21

Question 13

(a)	**(i)**	8.27 or 8.269... nfww	**4**	**M2** for $7.6^2 + 8.4^2 - 2 \times 7.6 \times 8.4 \times \cos(62)$ oe or **M1** for implicit form **A1** for $[PQ^2 =]$ 68.3 to 68.5
	(ii)	28.2 or 28.18..	**2**	**M1** for $0.5 \times 7.6 \times 8.4 \times \sin 62$ oe
(b)		55.8 or 55.78 to 55.79 nfww	**5**	**B1** for $[HGJ] = 81$ **B1** for $[GHJ] = 61$ **M2** for $[GJ =] \frac{63}{\sin(their\ 81)} \times \sin(their\ 61)$ or **M1** for implicit form After **M0, SC1** for final answer of 68.1…

Question 14

(a)	**(i)**	10.6 or 10.59...	**2**	**M1** for $\tan = \frac{55}{294}$ oe
	(ii)	175 or 174.9[…] to 175.[1…]	**4**	**M2** for $[\text{adj} =] \frac{55}{\tan 24.8}$ oe or **M1** for implicit version **and** **M1** dep on at least **M1** for $294 - their$ adj
(b)	**(i)**	4.9 or 4.89 to 4.9	**4**	**M3** for $\sqrt{4^2 + \left(\frac{1}{2}\sqrt{4.8^2 + 3^2}\right)^2}$ or **M2** for $\frac{1}{2}\sqrt{4.8^2 + 3^2}$ or **M1** for $\sqrt{4.8^2 + 3^2}$ or $2.4^2 + 1.5^2$
	(ii)	54.7 or 54.71 to 54.722	**2**	**M1** for $\sin = \frac{4}{their\ 4.9}$

Question 15

(a)	2180 or 2181…. nfww	**4**	**M2** for $680^2 + 2380^2 - 2 \times 680 \times 2380 \cos 65$ oe or **M1** for correct implicit cosine formula **A1** for 4 760 000 or 4 758 000 to 4 759 000
(b)	78.7 or 78.71…	**3**	**M2** for $\frac{2380 \sin 40}{1560}$ or **M1** for $\frac{1560}{\sin 40} = \frac{2380}{\sin M}$ oe
(c)	309 or 308.7…	**2FT**	**FT** 230 + *their* **(b)** **B1FT** 50 + *their* **(b)** for 129 or 128.7… [i.e. for C from M]
(d) (i)	23 39 oe	**1**	
(ii)	650	**2**	**M1** for 1560 ÷ journey time

Question 16

(a)	1.6[0] or 1.601 to 1.602	**3**	**M2** for $\frac{0.6}{\cos 68}$ oe or **M1** for $\cos 68 = \frac{0.6}{AC}$
(b)	43.5 or 43.6 or 43.49 to 43.56	**4**	**M2** for $\frac{1.9^2 + 2.3^2 - \textit{their}1.6^2}{2 \times 1.9 \times 2.3}$ or **M1** for implicit statement **A1** for [cos =] 0.724 to 0.726
(c)	1.33 or 1.332...nfww	**4**	**M2** for $\sqrt{2.3^2 - \left(\frac{1}{2} \times 1.2\right)^2}$ or **M1** for $2.3^2 = h^2 + (0.5 \times 1.2)^2$ **and M1** for $\frac{1}{2} \times 1.2 \times \textit{their}2.22$ (*their* 2.22 must come from attempt at Pythag or from trig in triangle BCD)
(d)	41.1 or 41.13 to 41.14	**3**	**M2** for $\sin = \frac{1.25}{1.9}$ oe or **M1** for correct angle identified

Question 17

(a) (i)	25.4 or 25.35… nfww	**5**	**M2** for $\sqrt{60^2 - 50^2}$ oe soi by 33.1 to 33.2 or **M1** for $TB^2 + 50^2 = 60^2$ oe **and** **M2** for tan = $\frac{theirTB}{70}$ oe or **B1** for recognising angle *TCB* as required angle
(ii)	109 or 109.0 to 109.1	**4**	**M2** for $50^2 + 70^2 - 2 \times 50 \times 70 \times \cos 130$ **M1** for implicit cos rule **A1** for 11 899 to 11 900
(iii)	1 340 or 1 340.0 to 1 341	**2**	**M1** for $\frac{1}{2} \times 50 \times 70 \times \sin 130$ oe
(b)	51.5 or 51.50 to 51.51	**4**	**M3** for $[XY] = \sqrt{45^2 + 22^2 + 12^2}$ or **M2** for $[XY^2 =] 45^2 + 22^2 + 12^2$ soi by 2 653 or **M1** for $45^2 + 22^2$ oe or $45^2 + 12^2$ oe or $12^2 + 22^2$ oe

Question 18

(a) (i)	275	**2**	**M1** for 360 – 40 – 45 oe
(ii)	095	**2FT**	**FT** *their* (a) – 180 **M1** for *their* (a) – 180 oe or 180 – 40 – 45
(b)	464.66 to 464.67 [= 464.7]	**4**	**M2** for $510^2 + 720^2 - 2 \times 510 \times 720 \cos 40$ or **M1** for correct implicit equation **A1** for 215 900 to 215 920
(c)	44.9 or 44.86 to 44.87…	**3**	**M2** for $\frac{510 \sin(40)}{464.7}$ or **M1** for correct implicit equation

Question 19

(a)	360 – 210 [= 150] (180 – 150) ÷ 2 [= 15] **or** 150 ÷ 2 [=75] and 180 – 75 – 90 [=15]	**M1** **M1**	
(b)	15.5 or 15.45 to 15.46 nfww	**4**	**M3** for $2 \times 8 \cos 15$ oe or **M2** for $8 \cos 15$ oe or **M1** for $\frac{x}{8} = \cos 15$ oe
(c)	29.5 or 29.4 or 29.39 to 29.50..	**3**	**M2** for [sin ABC =] $\frac{8 \times \sin 72}{their(b)}$ or **M1** for $\frac{\sin ABC}{8} = \frac{\sin 72}{their(b)}$ oe
(d)	194 or 193.7 to 194.1 nfww	**6**	**M2** for $\frac{210}{360} \times \pi \times 8^2$ or **M1** for [k] $\pi \times 8^2$ seen **and** **M1** for ½ × 8^2 × sin 150 oe **and M2** for ½ × 8 × *their* (b) × sin(108 – *their* (c)) oe or **B1** for [angle CAB=] 108 – *their* (c)
(e)	12.1 or 12.11 to 12.13	**2FT**	**FT** *their* (d) ÷ 4^2 oe **M1** for 4^2 or $\left(\frac{1}{4}\right)^2$ soi

Question 20

(a)	270 or 270.17 to 270.22	**3**	**M2** for $\frac{360-145}{360} \times \pi 12^2$ oe or **B1** for 215 seen or **M1** for $\frac{\theta}{360} \times \pi 12^2$ used
(b)	518 or 517.6 to 517.8 nfww	**6**	**B4** for vertical height = 9.62 to 9.63 or **B3** for radius = 7.166 to 7.17 or **B2** for length of sector = 45.[0] or 45.02 to 45.04

Question 21

(a)	$[\cos ABL =] \dfrac{40^2 + 61.1^2 - 92.1^2}{2 \times 40 \times 61.1}$	**M2**	**M1** for correct implicit version
	130.11…	**A2**	**A1** for $[\cos ABL =]$ –0.644… or $-\dfrac{7873}{12220}$ or $-\dfrac{3149.2}{4888}$
(b)	[0]59.5 or 59.50 to 59.511	**4**	**M2** for $\dfrac{40\sin 130.1}{92.1}$ or $\dfrac{61.1\sin 130.1}{92.1}$ or **M1** for $\dfrac{\sin A}{40} = \dfrac{\sin 130.1}{92.1}$ or $\dfrac{\sin L}{61.1} = \dfrac{\sin 130.1}{92.1}$ **and** **A1** for 19.39 to 19.4… or 30.48 to 30.49…
(c)	1h 50min	**5**	**M2** for $[BC =] 2 \times 40 \times \cos(180 - 130.1)$ oe or **M1** for $\dfrac{x}{40} = \cos(180 - 130.1)$ oe OR **M2** for $[BC =] \sqrt{\{40^2 + 40^2 - 2 \times 40 \times 40\cos(\textit{their } 80.2)\}}$ or **M1** for correct implicit version OR **M2** for $[BC =] \dfrac{40\sin(\textit{their } 80.2)}{\sin 49.9}$ or **M1** for correct implicit version

Question 22

(c)	328 or 328.3 to 328.5	**5**	**B1** for [angle A =] 78.75 seen **M2** for $180^2 + (their\ AB)^2 - 2\times180\times their\ AB\times\cos 78.75$ or **M1** for $\cos 78.75 = \frac{180^2 + (their AB)^2 - x^2}{2\times180\times(their AB)}$ **A1** for 107 800 to 107 900
(d) (i)	108.75 or 108.7 or 108.8	**1**	
(ii)	288.75 or 288.7 or 288.8	**2FT**	**FT** 180 + *their* **(d)(i)** **M1** for 180 + *their* **(d)(i)** or 360 – (180 – *their***(d)(i)**)
(a)	$\frac{240\sin 85}{\sin 50}$	**M2**	or **M1** for $\frac{\sin 50}{240} = \frac{\sin 85}{AB}$ oe
	312 or 312.1 ….	**B1**	
(b)	$\frac{1}{2}\times180\times240\times\sin A = 12000$	**M1**	
	33.748 to 33.749	**A2**	**A1** for $\sin = \frac{24000}{43200}$ or better or 0.555 or 0.556 or $0.\dot{5}$ or 0.5555 to 0.5556

Question 23

(a)	115 or 114.5 to 114.6	**3**	**M2** for $\frac{r^2}{\frac{\pi r^2}{360}}$ or better or **M1** for $\frac{w}{360}\times\pi\times r^2 = r^2$
(b)	126	**3**	**M2** for $\frac{x}{360}\times 2\pi r[+2r] = [2r+]\frac{7\pi r}{10}$ or better or **M1** for $\frac{x}{360}\times 2\pi r$
(c)	120	**4**	**B3** for $\frac{y}{2} = 60$ or x (base angle) = 30 OR **M3** for $\cos x$ or $\sin\left(\frac{y}{2}\right) = \frac{\sqrt{3}}{2}$ oe or $\cos y = -\frac{1}{2}$ oe or **M2** for $\cos x$ or $\sin\left(\frac{y}{2}\right) = \frac{q\sqrt{3}}{2q}$ or $[\cos y] = \frac{q^2+q^2-\left(q\sqrt{3}\right)^2}{2\times q\times q}$ oe or **M1** for $\left[\left(q\sqrt{3}\right)^2 =\right] q^2+q^2-2\times q\times q\cos y$ oe After **M0**, **SC1** for $[h^2 =]q^2-\left(\frac{1}{2}q\sqrt{3}\right)^2$ or for q replaced by 1, 2, 4, etc.

Question 24

(a)	126 or 126.4 to 126.5	**3**	**M2** for $\sqrt{220^2 - 180^2}$ oe or **M1** for $BC^2 + 180^2 = 220^2$ oe
(b)	99.9 or 99.86 to 99.87	**4**	**M2** for $180^2 + 170^2 - 2 \times 180 \times 170 \cos 33$ or **M1** for $\cos 33 = \frac{180^2 + 170^2 - CD^2}{2 \times 180 \times 170}$ **A1** for 9970 or 9973 to 9974
(c)	92.6 or 92.58 to 92.59	**2**	**M1** for $\frac{\text{dist}}{170} = \sin 33$ oe
(d)	115.1 or 115.0 to 115.1	**3**	**M1** for $\cos = \frac{180}{220}$ oe **M1dep** for 47 + 33 + *their* angle *BAC*
(e)	19700 or 19708 to 19720	**3**	**M1** for 0.5 × 180 × 170 × sin33 oe or 0.5 × 180 × *their* **(c)** oe **M1** for 0.5 × 180 × *their* **(a)** oe or 0.5 × 180 × 220 × sin(*their BAC*) oe

Question 25

(a) (i)	5.14 or 5.135 to 5.142 nfww	**4**	**M2** for $[XY^2 =] 12.5^2 + 9.9^2 - 2 \times 12.5 \times 9.9 \times \cos 23$ or **M1** for implicit version **A1** for 26.4 to 26.5 OR **B1** for $[XYT =]$ 108 or $[TXY =]$ 49 **M2** for $\frac{12.5 \sin 23}{\sin(180-72)}$ oe or **M1** for $\frac{\sin(180-72)}{12.5} = \frac{\sin 23}{XY}$ oe
(ii)	15.6 or 15.7 or 15.64 to 15.68	**3**	**M2** for $[TZ=] \frac{9.9}{\sin 37} \times \sin(72)$ oe or **M1** for $\frac{9.9}{\sin 37} = \frac{TZ}{\sin 72}$ oe OR **M2** for $\frac{12.5 \times \sin(180-23-108)}{\sin 37}$ oe or **M1** for $\frac{\sin 37}{12.5} = \frac{\sin(180-23-108)}{TZ}$ oe
(b)	3.79 or 3.793 to 3.794	**4**	**M3** for $r = 20.5 \div \left(2 + \frac{3 \times 65 \times 2\pi}{360}\right)$ oe or **M2** for $20.5 = 2r + \frac{3 \times 65}{360} \times 2\pi r$ oe or **M1** for $[3 \times] \frac{65}{360} \times 2\pi r$ oe or $20.5 = 2r +$ expression involving π

Question 26

(a)	1120 or 1121.	**4**	**M2** for $[AC^2 =]$ $525^2 + 872^2 - 2\times525\times872\times\cos 104$ or **M1** for implicit version **A1** for 1 257 000 to 1 258 000
(b)	$[QB$ or $x =]$ 872 × tan 1 seen	**M2**	**M1** for $\tan 1 = \frac{QB}{872}$
(c)(i)	222 000 or 222 100. .... or 222 101	**2**	**M1** for $\frac{1}{2}\times525\times872\times\sin104$
(c)(ii)	5.55 or 5.550 to 5.553 nfww	**2FT**	**FT** *their* **(c)(i)** × $100^2 \div 20000^2$ **M1** for *their* **(c)(i)** × $100^2 \div 20000^2$ or restart

Question 27

(a)(i)	290	**2**	**M1** for 180 + 110 oe
(a)(ii)	156.8 or 156.7[9..]	**5**	**B1FT** for $CBA = 10°$ (*their* **(a)** – 280) and **B3** for [angle $ACB =$]13.2° or **M2** for $[\sin C] = \frac{50\sin(their10)}{38}$ or **M1** for $\frac{50}{\sin C} = \frac{38}{\sin(their10)}$ oe
(a)(iii)	8.68 or 8.677 to 8.684	**3**	**M2** for $[x =]50\sin(their10)$ oe or **M1** for $\sin(their10) = \frac{x}{50}$ oe or **M1** for a correct right-angled triangle drawn with 50 as hypotenuse

(b)(i)	$x(x-25)=2200$	**1**	and no errors seen
(b)(ii)	$\frac{-(-25)\pm\sqrt{(-25)^2-4(1)(-2200)}}{2(1)}$ or better	**B2**	**B1** for $\sqrt{(-25)^2-4(1)(-2200)}$ or better **or** for $\left(x-\frac{25}{2}\right)^2$ oe or **B1** for $\frac{-(-25)+\sqrt{q}}{2(1)}$ or $\frac{-(-25)-\sqrt{q}}{2(1)}$ or both or for $\frac{25}{2}+\text{or}-\sqrt{\left(\frac{25}{2}\right)^2+2200}$
	–36.04 and 61.04 final answer	**B1,B1**	If **B0B0, SC1** for values in ranges –36.042 to –36.041 **and** 61.041 to 61.042 seen or for answers –36[.0] or –36.042 to –36.041 **and** 61[.0] or 61.041 to 61.042 or –36.04 **and** 61.04 seen in working or for –61.04 **and** 36.04 as final ans

Question 28

(a)	5.68 or 5.684 to 5.685	**5**	**M2** for $2x\sqrt{x^2+x^2}$ oe or $2\times\sqrt{2}\times x^2$ or **M1** for $x\sqrt{2}$ or $\sqrt{x^2+x^2}$ oe soi **M1** for $\frac{270}{360}\times\pi\times x^2$ oe **M1** for $0.5\,x^2$ oe
(b)	4.4[0] or 4.398 to 4.401	**2**	**dep** on a correct value for k in **(a)** **M1** for $\left[x^2\right]=\frac{110}{\textit{their } k}$

Question 29

(a)	7040 or 7035. …	**3**	**M1** for $\frac{1}{2}\times 100\times 70$ oe **M1** for $\frac{1}{2}\times 100\times 110\times \sin 40$ oe
(b)	374 or 375 or 374.4 to 374.5….	**5**	**M2** for $110^2+100^2-2\times 110\times 100\times \cos 40$ oe or **M1** for implicit form **A1** for 5250 or 5247. … (or 72.4 or 72.43 to 72.44) **M1** for 70^2+100^2
(c)	64.3 or 64.27 to 64.28 nfww	**2**	**M1** for $\sin 40 = \frac{\text{distance}}{100}$ oe
(d)	235	**3**	**B2** for [angle ACB =] 34.99 to 35 or [angle ABC =] 55[.0…] or **M1** for $\tan[\,ACB\,] = \frac{70}{100}$ or $\tan[\,ABC] = \frac{100}{70}$ or equivalent trig ratio

Question 30

(a)	356 or 356.2 to 356.3	**4**	**B1** for [Angle LPM] = 74 soi **M2** for $\frac{248\times \sin \textit{their } 74}{\sin 42}$ oe or **M1** for implicit statement
(b)(i)	320 or 319.9 to 320.2...	**3**	**B1** for angle PLM = 64 soi or for angle between LM and perpendicular from M = 26 soi or [PM =] 333.[1…] **M1** for *their* 356 × sin *their* 64 oe or *their* 356 × cos *their* 26 oe
(b)(ii)	02 57 or 2 57 am	**3**	**B2** for 6 hours 12 mins or 372 mins seen or **M1** for 248 ÷ 40 oe If 0 scored, **SC1** for *their* time in hours converted to hours and minutes

Question 31

(a)	128	**2**	**M1** for $4\times\frac{1}{2}\times8\times8$ oe
(b)(i)	18.3 or 18.26 to 18.29…	**3**	**M2** for $\frac{1}{4}(\pi\times8^2-their128)$ oe or **M1** for $\pi\times8^2-their128$ oe or for $\frac{1}{4}\times\pi\times8^2$ oe OR **SC2dep** for answer 4.56 to 4.57...
(b)(ii)	23.9 or 23.87 to 23.882	**4**	**M3** for $\frac{90}{360}\times2\times\pi\times8+\sqrt{8^2+8^2}$ oe OR **M1** for $\frac{90}{360}\times2\times\pi\times8$ oe **M1** for $\sqrt{128}$ oe OR **SC3dep** for answer 11.9 or 11.93 to 11.94…

Question 32

(a)(i)	116.6 or 116.56 to 116.57	**4**	**M1** for $\sin[EAD]=\frac{6}{12}$ oe **M1** for $\tan[BAC]=\frac{6}{12}$ oe **B1** for [angle DAC] = 60
(a)(ii)	13.4 or 13.41 to 13.42	**2**	**M1** for 12^2+6^2
(a)(iii)	10.4 or 10.39…	**3**	**M2** for $\sqrt{12^2-6^2}$ or **M1** for $AE^2+6^2=12^2$
(a)(iv)	130 or 129.5… to 129.6	**4**	**M1** for $0.5\times6\times theirAE$ oe **M1** for $0.5\times12\times12\times\sin60$ oe **M1** for $0.5\times6\times12$ oe
(b)(i)	3	**1**	
(b)(ii)	51.3 or 51.30 to 51.34…	**4**	**M3** for $\tan=\frac{8}{\sqrt{4^2+5^2}}$ or $\sin=\frac{8}{\sqrt{4^2+5^2+8^2}}$ oe or **M2** for $\sqrt{4^2+5^2}$ or $\sqrt{4^2+5^2+8^2}$ or **M1** for angle ARB clearly indicated

Question 33

(a)	$8^2 + 7^2 - 2 \times 7 \times 8 \times \cos 78$ oe	**M2**	**M1** for correct implicit version
	9.471.. to 9.472	**A2**	**A1** for 89.7…
(b)	46.3 or 46.29 to 46.30…	**3**	**M2** for $[\sin OAC =]\frac{7\sin 78}{9.47}$ or **M1** for $\frac{\sin OAC}{7}=\frac{\sin 78}{9.47}$
(c)	$29.5 - (7 + 8 + 9.47)$	**M1**	
	$\frac{360\times(29.5-(7+8+9.47))}{2\times\pi\times 7}$	**M3**	**M2** for $\frac{x}{360}\times 2\times\pi\times 7 =$ *their* arc length oe or **M1** for $\frac{x}{360}\times 2\times\pi\times 7$ oe
	41.15 to 41.171..	**B1**	
(d)	45[.0] or 44.98 to 45.01 nfww	**4**	**M3** for $\frac{1}{2} \times 8 \times 7 \times \sin 78$ oe $+ \frac{41.2}{360}\times\pi\times 7^2$ oe OR **M1** for $\frac{1}{2} \times 8 \times 7 \times \sin 78$ oe or $\frac{1}{2} \times 8 \times 9.47 \times \sin$ *their* **(b)** oe **M1** for $\frac{41.2}{360}\times\pi\times 7^2$ oe

Question 34

(a)	370 or 370.2 to 370.3	**2**	**M1** for 864 ÷ *their* time
(b)	991 or 990.5 …	**4**	**M2** for $864^2 + 928^2 - 2 \times 864 \times 928\cos 67$ or **M1** for correct implicit version **A1** for 981100 to 981110
(c)(i)	313	**2**	**M1** for 180 + 133 or 360 – 47
(c)(ii)	[0]79.5 to [0]79.6 …	**4**	**M2** for $\frac{928\times\sin 67}{\textit{their}\ 991}$ or $\frac{864\times\sin 67}{\textit{their}\ 991}$ oe or **M1** for implicit form of either **A1** for [angle *HGB* =] 59.5 to 59.6 … or [angle *HBG* =] 53.4 or 53.37 to 53.42 **M1 dep** for *their* angle *HGB* + 20 leading to answer or for 133 – *their* angle *HBG* leading to answer

Question 35

(a)	132.26 to 132.28 or 132.3	**5**	**B1** for angle *ABO* or angle *CBO* = 90 soi **M1** for $\tan[XOB] = \frac{15}{8}$ oe **M1** for $\tan[BOY] = \frac{22.4}{8}$ oe **A1** for [*BOY* =]70.3… or [*XOB* =] 61.9….
(b)	18.4 or 18.5 or 18.43 to 18.48	**2**	**M1** for $\frac{\textit{their}\ (\mathbf{a})}{360}\times 2\times\pi\times 8$ oe
(c)	75.7 to 75.9	**4**	**M1** for $\frac{1}{2}(15+22.4)\times 8$ oe **M2** for $\frac{\textit{their}\ (\mathbf{a})}{360}\times\pi\times 8^2$ oe or **M1** for one sector either $\frac{\textit{inv}\tan\left(\frac{15}{8}\right)}{360}\times\pi\times 8^2$ oe or $\frac{\textit{inv}\tan\left(\frac{22.4}{8}\right)}{360}\times\pi\times 8^2$ oe

Question 36

(a)	42.2 or 42.23....	**2**	**M1** for $\frac{1}{2}\times 8.9\times 12.5\times \sin 130.6$ oe
(b)(i)	27[.0] or 27.00 to 27.01	**3**	**M2** for $\frac{11.6\times \sin 123.5}{21.3}$
(b)(ii)	15.9 or 15.90 to 15.91	**5**	**M1** for angle ABD = *their* angle BCD + 33.5 **and** **M2** for $11.6^2+18^2-2\times 11.6\times 18\times \cos(their ABD)$ or **M1** for implicit version **A1** for 252.9 to 253

Question 37

(a)	5.83 or 5.832 to 5.833	**5**	**B2** for sector angle = 210 soi or **M1** for $[\cos DOE =]\frac{0.25}{0.5}$ oe **M2** for $\frac{their 210}{360}\times 2\times \pi\times 0.5+2\times 1.5+2\times 0.5$ oe or **M1** for $\frac{their 210}{360}\times 2\times \pi\times 0.5$ oe isw
(b)	1.21 or 1.208…	**3**	**M2** for $\frac{their 210}{360}\times \pi\times 0.5\times 0.5+1.5\times 0.5$ oe or **M1** for $\frac{their 210}{360}\times \pi\times 0.5\times 0.5$ oe isw

Question 38

(a)(i)	$\angle ACD = 46$ soi or $\angle CDE = 44$ soi	**B2**	**B1** for angle $ADC = 108$ or angle $DCB = 18$
	$\frac{58\sin 108}{\sin their 46}$	**M2**	**M1** for $\frac{\sin 108}{x} = \frac{\sin their 46}{58}$ oe
	76.68… nfww	**A1**	
(a)(ii)	10.9 or 10.91 to 10.94	**3**	**B2** for $[AB =]$ 68.9 or 68.91 to 68.94 or **M2** for a correct explicit statement for AB or BD or **M1** for $\frac{AB}{76.7} = \cos 26$ oe
(b)(i)	10.4 or 10.43 to 10.44	**4**	**M3** for $\sqrt{\frac{70}{\sin 40}}$ oe or **M2** for $x^2 \times \sin 40 = 70$ oe or **M1** for $\frac{1}{2}x \times 2x \times \sin 40 = 70$
(b)(ii)	140	**1**	

Question 39

(a)(i)	15.7 or 15.70...	**4**	**M2** for $16.5^2 + 12.4^2 - 2\times 16.5\times 12.4\times \cos 64$ or **M1** for implicit form **A1** for 246 to 247
(a)(ii)	18.7 or 18.68 to 18.69	**4**	**B1** for 32 or angle $DBM = 37$ or angle $CBM = 58$ **M2** for $\frac{12.4\times \sin 53}{\sin 32}$ oe or **M1** for implicit form oe
(b)(i)	116.1 or 116.08 to 116.09...	**2**	**M1** for $\frac{y}{360}\times 2\times \pi \times 3.8 = 7.7$ oe
(b)(ii)	14.6 or 14.61 to 14.63…	**2**	**M1** for $\frac{their\textbf{(b)(i)}}{360}\times \pi \times 3.8^2$ oe

Question 40

(a)	530	**4**	**B3** for $[DE] = 130$ m and $[DC] = 80$ m or **B2** for $[DE] = 130$ m or $[DC] = 80$ m or **M1** for $50^2 + 120^2$ or $170^2 - 150^2$
(b)	52.9 or 52.89…	**4**	**M2** for $\frac{100^2 + 150^2 - 120^2}{2 \times 100 \times 150}$ or **M1** for $120^2 = 100^2 + 150^2 - 2 \times 100 \times 150\cos(\ldots)$ **A1** for 0.603 or 0.6033…or $\frac{181}{300}$
(c)(i)	28.1 or 28.07…	**2**	**M1** for $\cos = \frac{15}{17}$ oe
(c)(ii)	331.9 or 331.9…	**2**	**FT** 360 – *their* **(c)(i)** **M1** for 360 – *their* **(c)(i)** oe
(d)	1.5[0] or 1.498… nfww	**4**	**M1** for $\frac{1}{2} \times 50 \times 120$ oe **M1** for $\frac{1}{2} \times 100 \times 150 \sin(\textit{their}\textbf{(b)})$ oe **M1** for $\frac{1}{2} \times 150 \times \textit{their}CD$ oe or $\frac{1}{2} \times 150 \times 170 \times \sin \textit{their}\textbf{(c)(i)}$ If 0 scored, **SC1** for dividing *their* area by 10 000

Question 41

(a)	36.8 or 36.84…	**2**	**M1** for $\frac{h}{107} = \tan 19$ or $\frac{h}{\sin 19} = \frac{107}{\sin 71}$ oe or better
(b)	42.1 or 42.12… from cosine rule	**4**	**M2** for $[\cos BAC =] \frac{158^2 + 132^2 - 107^2}{2 \times 158 \times 132}$ or **M1** for implicit version **A1** for $[\cos BAC =] \frac{30939}{41712}$ or 0.7417…
(c)	35.8 or 35.84… from sine rule	**3**	**M2** for $\frac{86 \times \sin 116}{132} [= 0.58557...]$ or **M1** for $\frac{\sin CAD}{86} = \frac{\sin 116}{132}$ oe
(d)	9670 or 9669 to 9676	**3**	**M2** for $\frac{1}{2} \times 158 \times 132 \times \sin(their\ (b))$ oe and $\frac{1}{2} \times 86 \times 132 \times \sin(64 - their\ (c))$ oe or **M1** for either area
(e)	214.2 or 214.1… or 214	**2**	**M1** for [180 +]70–*their* (c) oe

Question 42

(i)	13.9[0…] from cosine rule	**4**	**M2** for $8^2 + 13^2 - 2 \times 8 \times 13\cos 79$ or **M1** for $\cos 79 = \frac{13^2 + 8^2 - BC^2}{2 \times 8 \times 13}$ **A1** for 193 ....
(ii)	66.6 or 66.60… to 66.65 from sine rule	**3**	**M2** for $[\sin ACB =] \frac{13 \times \sin 79}{their(a)(i)}$ or **M1** for $\frac{\sin ACB}{13} = \frac{\sin 79}{their(a)(i)}$ oe

Question 43

(a)	4.29 or 4.285 to 4.286	**3**	**M2** for $\dfrac{150}{\frac{450}{3.6}-\frac{120}{4}-\frac{180}{3}}$ or **M1** for [time =] 120 ÷ 4 or 180 ÷ 3 or 450 ÷ 3.6 or $3.6=\dfrac{150+180+120}{\text{total time}}$
(b)	82.8 or 82.81 to 82.82 using cosine rule	**4**	**M2** for $\dfrac{150^2+120^2-180^2}{2\times150\times120}$ or **M1** for $180^2=120^2+150^2-2\times120\times150\cos(...)$ **A1** for $\dfrac{4500}{36000}$ oe
(c)(i)	127.2 or 127.1 to 127.2 or 127	**1**	**FT** 210 – *their* (b)
(c)(ii)	307.2 or 307.1 to 307.2 or 307	**2**	**FT** 180 + *their*(c)(i) **M1** for 180 + *their* (c)(i)
(d)	15 or 14.99 to 15.04	**2**	**M1** for $\cos(\textit{their}\ (b))=\dfrac{\text{dist}}{120}$ oe

Question 44

(i)	2.67 or 2.666…	**3**	**M2** for $\dfrac{6\times\sin25}{\sin72}$ or **M1** for implicit version
(ii)	4.14 or 4.140…	**3**	**M1** for $6^2+7.4^2-2\times6\times7.4\times\cos34$ **A1** for 17.1 to 17.2
(iii)	20.4 or 20.35 to 20.36…	**4**	**B1** for angle $SQR = 83$ **M1** for $\frac{1}{2}\times6\times$*their* **(a)(i)** $\times\sin$ *their* (180–72–25) oe **M1** for $\frac{1}{2}\times6\times7.4\times\sin34$ oe

Question 45

(a)(i)	29.5 or 29.50…	**4**	**M2** for $\frac{11^2+5.3^2-6.9^2}{2\times11\times5.3}$ or **M1** for $6.9^2 = 11^2 + 5.3^2 - 2\times11\times5.3\cos x$ **A1** for 0.87[0…] oe
(a)(ii)	13.4 or 13.38…	**4**	**B1FT** 84 – *their* **(*a*)(i)** **M2** for $\frac{11}{\sin 42}\times\sin \textit{their}\, 54.5$ or **M1** for implicit form
(b)	2700	**4**	**M2** for $15\times2.5\times20\times60\times60$ or **M1** for $15\times2.5\times20$ **M1** for *their* volume ÷ 1000 If 0 scored, **SC1** for figs 27 with no working

Question 46

(a)	[0]38 or [0]37.9 or [0]37.87...	**2**	**M1** for tan = $\frac{350}{450}$ oe If 0 scored, **SC1** for answer [0]52 or [0]52.1 or [0]52.12 to [0]52.13
(b)	624 or 623.8 to 623.9	**6**	**M2** for 450 – 400 sin 50 or **M1** for sin 50 = $\frac{...}{400}$ **M2** for 350 + 400 cos 50 or **M1** for cos 50 = $\frac{...}{400}$ **M1** for (*their* (450 – 400 sin 50))^2 + (*their* (350 + 400 cos 50))^2
(c)	10 min 8 s	**4**	**B3** for 10.1 or 10.13… or **M2** for (400 + 350 + 450 + *their DA*) ÷ 3 [÷ 60] oe or **M1** for any distance ÷ 3 **M1** for rounding *their* minutes into minutes and seconds to nearest second if clearly seen

Question 47

(a)	65.4 or 65.36 to 65.37	**3**	**M1** for $150^2 + 120^2 - 2 \times 150 \times 120 \cos 25$ **A1** for 4270 or 4272 to 4273
(b)	125 or 124.7 to 124.8	**4**	**B1** for [angle S =] 80 **M2** for $\frac{150\sin 55}{\sin \textit{their}80}$ or **M1** for $\frac{\sin \textit{their}80}{150} = \frac{\sin 55}{RS}$ oe
(c)	10 400 or 10 410 to 10 440 nfww	**3**	**M1** for $\frac{1}{2} \times 120 \times 150 \sin 25$ oe **M1** for $\frac{1}{2} \times 150 \times \textit{their}$ **(b)** $\sin 45$ oe

Question 48

(a)	39[.0] or 39.03 to 39.04…	**3**	**M2** for $\frac{165}{360} \times 2 \times \pi \times 8 + 16$ or **M1** for $\frac{165}{360} \times 2 \times \pi \times 8$
(b)	2.71 or 2.708…	**4**	**M3** for $\sqrt{\frac{\frac{165}{360}[\times \pi] \times 8^2}{4[\times \pi]}}$ oe or **M2** for $r^2 = \frac{\frac{165}{360}[\times \pi] \times 8^2}{4[\times \pi]}$ oe or **M1** for $\frac{165}{360} \times \pi \times 8^2$ oe seen
(c)(i)	3.67 or 3.666 to 3.667	**2**	**M1** for $\frac{165}{360} \times 2[\times \pi] \times 8 = 2[\times \pi] \times r$ or better or for $\frac{165}{360}[\times \pi] \times 8^2 = [\pi \times] r \times 8$ or better
(c)(ii)	100 or 100.0 to 100.1… final answer	**4**	**M3** for $\frac{1}{3} \pi \times \textit{their}(c)(i)^2 \times \sqrt{8^2 - \textit{their}\,\text{radius}^2}$ or **M2** for $\sqrt{8^2 - \textit{their}\,\text{radius}^2}$ or **M1** for $(\textit{their}\ (c)(i))^2 + h^2 = 8^2$

Question 49

(a)	$[BC^2 =]\ 80^2 + 115^2 - 2 \times 80 \times 115 \cos 72$ oe	**M1**	
	118.06…	**A2**	**A1** for 13939…
(b)	67.8 or 67.9 or 67.83 to 67.88	**3**	**M2** for $[\sin B =]\ \frac{115 \times \sin 72}{118.1}$ oe or **M1** for $\frac{115}{\sin B} = \frac{118.1}{\sin 72}$ oe
(c)(i)	255	**3**	**B1** for bearing of B from A is 75 soi **M1** for 180 + 75 oe
(c)(ii)	[00]7.2	**2**	**M1** for *their* **(c)(i)** – *their* **(b)** –180
(d)	11.8 or 11.82 to 11.83	**3**	**M1** for 115 ÷ 35 oe **M1** for *their* speed in m/s × 60 × 60 ÷ 1000
(e)	76.1 or 76.08 to 76.09	**3**	**M2** for $\frac{\text{distance}}{80} = \sin 72$ oe or **M1** for distance required is perpendicular to AC soi

Question 50

(a)	440	**2**	**M1** for $8 \times 5 \times 11$
(b)	$\sqrt{8^2 + 5^2 + 11^2}$ oe or $8^2 + 5^2 + 11^2$ and 13^2 ALTERNATIVE $\sqrt{8^2 + 11^2}$ or $8^2 + 11^2$ and 13^2	**M3**	**M2** for $8^2 + 5^2 + 11^2$ or $8^2 + 11^2$ oe or **M1** for $8^2 + 5^2$ or $5^2 + 11^2$ oe
	Yes and 14.5 or 14.4 or 14.49… or Yes and 13.6[0…]	**A1**	Accept equivalent conclusion
(c)(i)	32.0[…]	**2**	**M1** for $\tan[..] = \frac{5}{8}$ oe
(c)(ii)	49.4 or 49.38 to 49.39	**2**	**M1** for $\sin[..] = \frac{11}{\textit{their } AG}$ oe

Question 51

(a)(i)	106.01 to 106.02	**4**	**M2** for $[\cos[\angle CBD] =] \frac{192^2 + 168^2 - 287.9^2}{2 \times 192 \times 168}$ oe or **M1** for the implicit form **A1** for –0.276 to – 0.275
(a)(ii)	292.0 or 291.98 to 291.99	**1**	
(a)(iii)	310.0 or 310.03 to 310.04	**5**	**M2** for $[\sin A =] \frac{168 \times \sin(90 - 38)}{205.8}$ or **M1** for $\frac{\sin A}{168} = \frac{\sin(90 - 38)}{205.8}$ **A1** for [A =] 40.0 or 40.03 to 40.04 **M1 dep** for 270 + *their* angle DAB oe
(b)(i)	15 500 or 15 501 to 15 503. …	**2**	**M1** for $0.5 \times 192 \times 168 \times \sin(106)$ oe
(b)(ii)	55 400	**2**	**FT** $3.575 \times$ *their* **(b)(i)** oe rounded to nearest 100 **M1** for figs 35 75 × figs *their* **(b)(i)** or figs 554 or figs 5541 to figs 5543

Question 52

(a)	27[.0] or 26.97… nfww	**3**	**M2** for $[\cos =] \frac{8.6^2 + 9.7^2 - 4.4^2}{2 \times 8.6 \times 9.7}$ or **M1** for implicit form
(b)	9.19 or 9.192 to 9.193	**4**	**B1** for [angle BCD =] 73 seen **M2** for $\frac{9.7 \times \sin 65}{\sin(180 - 65 - 42)}$ oe or **M1** for $\frac{\sin(180 - 65 - 42)}{9.7} = \frac{\sin 65}{DC}$ oe
(c)	6.15 or 6.149 to 6.151…	**3**	**M2** for $\frac{d}{\textit{their}\,9.19} = \sin 42$ oe or **M1** for right angle between line from C to BD and BD soi

Question 53

(a)	42.3 or 42.28 to 42.30...	**7**	**M1** for $\frac{AB}{14} = \cos 35$ oe **M1** for $\frac{AD}{14} = \sin 35$ oe **B1** for $[C =]$ 75 **M3** for [BC =] $\frac{14 \sin 60}{\sin their 75}$ oe **and** [DC] $\frac{14 \sin 45}{\sin their 75}$ oe or **M2** for $\frac{14 \sin 60}{\sin their 75}$ **or** $\frac{14 \sin 45}{\sin their 75}$ oe or **M1** for $\frac{\sin their 75}{14} = \frac{\sin 60}{BC}$ oe or $\frac{\sin their 75}{14} = \frac{\sin 45}{CD}$ oe
(b)(i)	4.91 or 4.907...	**3**	**B2** for $[l^2 =]$ 24.1 or 24.08... or M2 for $\sqrt{3}\, l = 8.5$ or $[l =] \sqrt{\frac{8.5^2}{3}}$ oe or **M1** for $l^2 + l^2 + l^2 = 8.5^2$ oe
(b)(ii)	35.3 or 35.26 to 35.3 nfww	**3**	**M2dep** for sin (angle) = $\frac{their \textbf{ (b)(i)}}{8.5}$ oe or **M1** for clear recognition of correct angle

Question 54

(a)	$\sqrt{16^2+19^2-2\times16\times19\cos57}$ oe	**M2**	or **M1** for $16^2 + 19^2 - 2\times16\times19\cos57$ **A1** for 285.8 to 285.9
	16.90 to 16.91	**A1**	
(b)	74.3 or 74.30 to 74.33	**4**	**M2** for [sin ... =] $\frac{16.9\times\sin75}{32}$ oe or **M1** for $\frac{16.9}{\sin C}=\frac{32}{\sin75}$ oe **B1** for [angle BCD =] 30.7 or 30.67 to 30.69… or **M1dep** for 105 – *their* angle BCD
(c)	388 or 387.7 to 387.9… nfww	**3**	**M1** for $\frac{1}{2}\times16\times19\times\sin57$ oe **M1** for $\frac{1}{2}\times16.9\times32\times\sin$ *their* **(b)** oe
(d)	13.4 or 13.41 to 13.42 nfww	**3**	**M2** for $\frac{x}{16}=\sin57$ oe or **M1** for distance required is perpendicular to AD soi

Question 55

(a)	13.5 or 13.47…	**4**	**B1** for angle 102 seen **M2** for $\sqrt{10.6^2+6.4^2-2\times10.6\times6.4\times\cos(180-78)}$ OR **M1** for $10.6^2+6.4^2-2\times10.6\times6.4\times\cos(180-78)$ **A1** for 181.5…
(b)	8.68 or 8.682 to 8.683 nfww	**4**	**B1** for angle = 44 **M2** for $\sin(180-58-78)\times\frac{10.6}{\sin58}$ oe or **M1** for $\frac{\sin(180-58-78)}{x}=\frac{\sin58}{10.6}$ oe
(c)	78.2 or 78.17 to 78.19…	**3**	**M2** for $\frac{1}{2}\times10.6\times(6.4+$ *their* $8.68)\times\sin(78)$ **M1** for $\frac{1}{2}\times10.6\times6.4\times\sin(180-78)$ oe **M1** for $\frac{1}{2}\times10.6\times$ *their* $8.68\times\sin78$ oe

Question 56

(a)	9.33 or 9.334...	**3**	**M2** for $\frac{12\sin 50}{\sin 100}$ or **M1** for $\frac{\sin 100}{12}=\frac{\sin 50}{AD}$ oe
(b)	[cos =] $\frac{11^2+12^2-8^2}{2\times 11\times 12}$	**M2**	**M1** for $8^2=11^2+12^2-2\times 11\times 12\cos(BAC)$
	40.415...	**A2**	**A1** for 0.761... or $\frac{201}{264}$ or $\frac{67}{88}$
(c)	70.8 or 70.77 to 70.79...	**3**	**M1** for $\frac{1}{2}\times 12\times$ *their* **(a)** $\times\sin(180-100-50)$ **M1** for $\frac{1}{2}\times 12\times 11\times\sin(40.42)$
(d)	7.13 or 7.131 to 7.132...	**3**	**M2** for $\frac{\text{dist}}{11}=\sin(40.42)$ or **M1** for recognition that shortest distance is perpendicular to AC

Question 57

(a)(i)	$\frac{AD}{46.1}$ = tan 64 oe or better	**M1**	
	94.51 to 94.52	**A1**	
(a)(ii)	46[.0] or 45.96… nfww	**3**	**M2** for $56.5 \times \frac{\sin 94}{78.4}$ oe or **M1** for $\frac{56.5}{\sin BAC} = \frac{78.4}{\sin 94}$ oe
(a)(iii)	102.3 or 102.4 or 102.34 to 102.38	**4**	**M2** for $[\cos C =] \frac{38.6^2 + 78.4^2 - 94.5^2}{2 \times 38.6 \times 78.4}$ or **M1** for $94.5^2 = 38.6^2 + 78.4^2 - 2 \times 38.6 \times 78.4 \times \cos C$ and **A1** for –0.214 or –0.2144 to –0.2137 If 0 scored, **SC2** for [*CAD* =] 23.5 or 23.51 to 23.52 or for [*CDA* =] 54.1 or 54.14…
(b)	16.2 or 16.15…	**3**	**M2** for $\frac{1}{2} \times 21.5 \times 27.6 \sin 111 = \frac{1}{2} \times 34.3 \times d$ oe or **M1** for $\frac{1}{2} \times 21.5 \times 27.6 \sin 111$ seen or $\frac{1}{2} \times 34.3 \times d$ oe soi

Question 58

85[.0], 265[.0] and no others	**2**	**B1** for each If 0 scored **SC1** for two values in the range with a difference of 180 but not multiples of 90

Question 59

(a)(i)	40.9 or 40.91…	**3**	**M2** for $[\sin ABC =]\ \frac{29.5\sin 51.6}{35.3}$ oe or for $[\cos ABC =]\ \frac{35.3^2+45^2-29.5^2}{2\times 35.3\times 45}$ or **M1** for $\frac{29.5}{\sin ABC}=\frac{35.3}{\sin 51.6}$ oe or for correct implicit cosine rule
(a)(ii)	520 or 520.0 to 520.2…	**2**	**FT** *their* (a)(i) if used provided working shown **M1** for $0.5\times 29.5\times 45\times \sin 51.6$ oe or for $0.5\times 35.3\times 45\times \sin(\textit{their}\text{(a)(i)})$ or for 0.5 × 35.3 × 29.5sin (180–51.6–*their*(a)(i))
(b)(i)	41.2 or 41.21 to 41.23	**4**	**M1** for $SQ = 2\times 32\times \sin\left(\frac{1}{2}\times 56\right)$ oe or $\sqrt{32^2+32^2-2\times 32\times 32\times \cos 56}$ oe or $\frac{32\sin 56}{\sin((180-56)\div 2)}$ oe **M2** for $SR^2 = 47^2+\left(\textit{their}\ SQ^2\right)-2\times 47\times \textit{their}\ SQ\times\cos 60$ or **M1** for implicit form
(b)(ii)	28.3 or 28.25 to 28.29…	**3**	**M2** for 32 × sin62 oe or **M1** for recognition that line from *P* is perpendicular to *SQ*

Question 60

(a)	20.8 or 20.76 to 20.79	**4**	**B3** for $[BC =]$ 10.4 or 10.38 to 10.39… or $6\sqrt{3}$ oe or **M2** for $(2x)^2 + x^2 + 6^2 = 24^2$ oe or **M1** for $24^2 - 6^2$ oe or $x^2 + 6^2$ oe or $(2x)^2 + 6^2$ oe, or $x^2 + (2x)^2$ oe or **SC2** for final answer of $12\sqrt{5}$ or 26.8 or 26.83…
(b)	14.5 or 14.47 to 14.48	**3**	**M2** for $\sin[\ldots] = \frac{6}{24}$ oe or **M1** for recognising the correct angle *GAC*

Question 61

'(a)	87.[0] or 86.98 to 86.99	**3**	**M2** for $\sqrt{82^2+55^2-2\times82\times55\times\cos 76}$ oe OR **M1** for $82^2+55^2-2\times82\times55\times\cos 76$ oe **A1** for 7570 or 7566 to 7567
'(b)	66.1 or 66.2 or 66.13 to 66.17	**3**	**M2** for $\frac{82\times\sin 76}{\textit{their}\ \textbf{(a)}}$ oe or **M1** for $\frac{82}{\sin C}=\frac{\textit{their}\ \textbf{(a)}}{\sin 76}$ oe
'(c)	13.3 or 13.30 to 13.31	**3**	**M2** for $AG = 55\cos 76$ oe or **M1** for recognition that CG is perpendicular to AB
'(d)	54.1 or 54.13… **and** 125.9 or 125.86 to 125.87	**5**	**B4** for 54.1 or 54.13… or 125.9 or 125.86 to 125.87 **M3** for [sin Q =] $\frac{0.5\times82\times55\times\sin 76}{0.5\times90\times60}$ oe or **M2** for $0.5\times82\times55\times\sin 76 = 0.5\times60\times90\times\sin Q$ oe or **M1** for $0.5\times82\times55\times\sin 76$ oe or for $0.5\times60\times90\sin Q$ = *their* area of ABC If **B4** not scored then **SC1** for two angles seen that sum to 180 (from use of sine ratio) but not 0 and 180.

Question 62

(a)	7.06 or 7.058… or 7.059	**3**	**M2** for $\sqrt{6.4^2+10.9^2-2\times6.4\times10.9\times\cos 38}$ oe OR **M1** for $6.4^2+10.9^2-2\times6.4\times10.9\times\cos 38$ oe **A1**= 49.8...
(b)(i)	97	**1**	
(b)(ii)	15.3[0…]	**3**	**M2** for $[AB=]\ \frac{10.9\times\sin \textit{their}\ 97}{\sin 45}$ or **M1** for $\frac{\sin \textit{their}\ 97}{AB}=\frac{\sin 45}{10.9}$ oe
(c)	72.8 to 72.81…	**3**	**M2** for $\frac{1}{2}(6.4)\times10.9\times\sin 38+\frac{1}{2}\textit{their}\ 15.3\times10.9\times\sin 38$ oe or **M1** for $\frac{1}{2}\times6.4\times10.9\times\sin 38$ oe or $\frac{1}{2}\times\textit{their}15.3\times10.9\times\sin 38$ oe or **M1** for height =$10.9\times\sin38$ oe

Question 63

(a)	39.6 or 39.57....	**4**	**M2** for $[\cos=]\ \frac{14^2+12^2-9^2}{2\times14\times12}$ or **M1** for $9^2=14^2+12^2-2\times14\times12\times\cos ACD$ **A1** for 0.7708... or 0.771 or $\frac{37}{48}$ oe
(b)	$\frac{14\sin 25}{\sin 123}$	**M2**	**M1** for $\frac{\sin 123}{14}=\frac{\sin 25}{BC}$ oe
	7.054…	**A1**	
(c)	3.74 or 3.735 to 3.739	**3**	**M2** for $7.05\times\sin 32$ or **M1** for recognition that the line from B is perpendicular to AC
(d)	11.8 or 11.83 to 11.85	**4**	**M1** for $32+\textit{their}(a)$ soi **M2** for $12^2+7.05^2-2\times12\times7.05\times\cos(\textit{their}(a)+32)$ or **M1** for $\cos(\textit{their}(a)+32)=\frac{12^2+7.05^2-BD^2}{2\times12\times7.05}$
(e)	309.6 or 309.57...	**2**	**FT** 270 + *their(a)* **M1** for 270 + *their(a)* oe

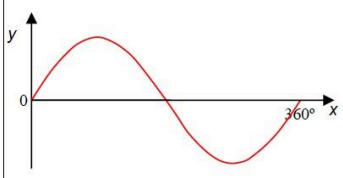
Question 64

(a)	$[\cos B =]\ \dfrac{9.5^2+7.7^2-10^2}{2\times9.5\times7.7}$ oe	**M2**	**M1** for $10^2 = 9.5^2 + 7.7^2 - 2\times9.5\times7.7\cos B$ oe or better
	70.206 to 70.207 or 70.21 to 70.22	**A2**	**A1** for $\dfrac{2477}{7315}$ 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 $\dfrac{5}{\cos\ \textit{their}\ \textbf{(b)(ii)}}$ oe or **M1** for $\dfrac{5}{r} = \cos(\textit{their}\ \textbf{(b)(ii)})$ oe
(d)	38.8 or 38.9 or 38.78 to 38.85	**4**	**M3** for $\dfrac{0.5\times9.5\times7.7\times\sin70.2}{\pi\times(\textit{their}\ \textbf{(c)})^2}$ [×100] OR **M1** for $0.5\times9.5\times7.7\times\sin70.2$ **M1** for $\pi\times(\textit{their}\ \textbf{(c)})^2$

Question 65

(a)	42.05 final answer	**2**	**M1** for 11.4 + 0.05 oe or 14.8 + 0.05 oe or 15.7 + 0.05 oe
(b)	319 or 318.5 to 318.6	**2**	**M1** for $\dfrac{150}{360}\times\pi\times15.6^2$ oe
(c)	$\dfrac{360-x}{360}\times2\pi r + 2r = 3\left(\dfrac{x}{360}\times2\pi r + 2r\right)$ oe	**M2**	**M1** for $\dfrac{x}{360}\times2\pi r$ oe seen or $\dfrac{360-x}{360}\times2\pi r$ oe seen
	$\dfrac{4x}{360}\times2\pi[r] = 2\pi[r] - 4[r]$ oe	**M1**	i.e. M mark for isolating and collecting terms in x
	Leading to $\dfrac{90(\pi-2)}{\pi}$	**A1**	With no errors or omissions

Question 66

(a)	Correct sketch to go through (0, 0), and (360, 0)  	**2**	**M1** for correct sine curve shape through the origin or for almost correct sketch fitting all tramlines but with an omission at either end or incorrect curvature in one place only
(b)	233.1 or 233.13… and 306.9 or 306.86 to 306.87	**3**	**B2** for one correct angle or **M1** for $\sin x = -0.8$ oe If 0 scored **SC1** for 2 reflex angles that add to 540 or two non-reflex angles that add to 180

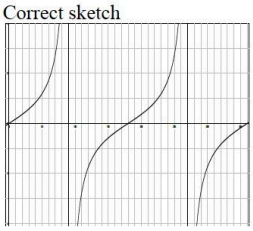
Question 67

(a)(i)	52.[0] or 52.01…	4	**M2** for $[\cos P =]\ \frac{39.4^2 + 46.5^2 - 38.2^2}{2 \times 39.4 \times 46.5}$ oe or **M1** for $38.2^2 = 39.4^2 + 46.5^2 - 2 \times 39.4 \times 46.5 \times \cos P$ oe **A1** for 0.616 or 0.6155…
(a)(ii)	36.6 or 36.64 to 36.65	3	**M2** for $\frac{d}{46.5} = \sin(\textit{their}\ 52.01)$ oe or **M1** for recognition that the line from Q is perpendicular to PR
(b)(i)	41[.0] or 41.01… nfww	3	**M2** for $29^2 + 21^2 + 20^2$ oe or better or **M1** for $29^2 + 21^2$ oe or $29^2 + 20^2$ oe or $21^2 + 20^2$ oe or better
(b)(ii)	29.2 or 29.18 to 29.2	3	**M2** for $\sin[GAC] = \frac{20}{\textit{their}\ AG}$ oe or **M1** for angle GAC identified
(c)	bearing 286	B2	**B1** for angle $MLK = 49$ or for angle $MKL = 35$ correctly identified or angle from North to $ML = 106$
	distance 64.6 or 64.59…	B3	**M2** for $\frac{112 \times \sin(\textit{their}\ 35)}{\sin(96)}$ oe or **M1** for the implicit form

Question 68

(a)	$[\cos =]\frac{15^2 + 8^2 - 20^2}{2.15.8}$	M2	**M1** for $20^2 = 15^2 + 8^2 - 2.15.8\cos(\ \ )$
	117.54 to 117.55	A2	**A1** for $-\frac{37}{80}$ or $-\frac{111}{240}$ or –[0].4625
(b)	53.2 or 53.19 to 53.23	2	**M1** for $0.5 \times 8 \times 15 \times \sin(117.5)$ oe
(c)	15.5 or 15.52 to 15.53	2	**M1** for $15^2 + 4^2$ oe
(d)	7.1 or 7.13 or 7.125 to 7.126	3	**M2** for $\tan [P] = \frac{4-3}{8}$ oe or for 7.1 or 7.13 or 7.125 to 7.126 seen or **M1** for vertical line = 4 – 3 soi After 0 scored **SC1** for correct angle identified
(e)	11.5 nfww or 11.48 to 11.49...	5	**B1** for height of 3.5 soi **M2** for $15^2 + 4^2 - 2.15.4\cos(117.5)$ or **M1** for $\cos 117.5 = \frac{15^2 + 4^2 - (...)^2}{2.15.4}$ **M1** for $\tan = \frac{3.5}{\textit{their}\ 17.216...}$ oe After M0 scored **SC1** for correct angle identified

Question 69

(a)	Correct sketch 	**2**	Condone curve touching asymptotes but not crossing **B1** for one section correct or for 3 sections in correct part of graph but with incorrect curvature and no other sections in incorrect part of graph
(b)	30 **and** 210 final answer	**2**	**B1** for each If 0 scored **SC1** for two answers (one acute and one reflex) with a difference of 180

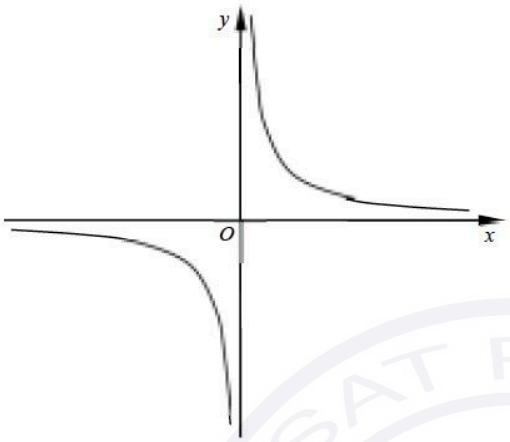
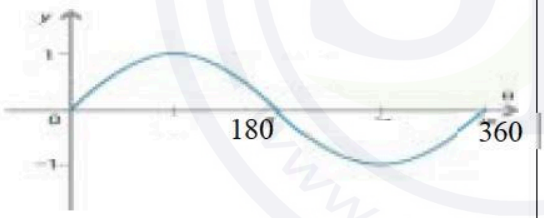
Question 70

(a)	$\cos 31 = \frac{AB}{12.3}$ oe	**M1**	
	10.543...	**A1**	
(b)	$\cos = \frac{12.3}{16.5}$ oe	**M1**	
	41.801 to 41.802	**A1**	
(c)	16.7 or 16.8 or 16.74 to 16.75…	**3**	**M2** for $\sqrt{10.54^2 + 16.5^2 - 2\times 10.54\times 16.5\times\cos(31+41.8)}$ or for $\sqrt{6.33^2 + 11^2 - 2\times 6.33\times 11\times\cos(180-31)}$ OR **M1** for $10.54^2 + 16.5^2 - 2\times 10.54\times 16.5\times\cos(31+41.8)$ or for $6.33^2 + 11^2 - 2\times 6.33\times 11\times\cos(90+90-31)$ oe **A1** for 280 or 281 or 280.4 to 280.6
(d)	18.9 to 20.7… nfww	**4**	**M1** for $\sin 31 = \frac{BC}{12.3}$ oe or better and $\sin 41.8[0] = \frac{CD}{16.5}$ oe **M2dep on M1** for $\cos[DBC] = \frac{their(c)^2 + 6.34^2 - 10.998^2}{2\times their(c)\times 6.34}$ or **M1dep on M1** for $10.998^2 = their$ **(c)**$^2 + 6.34^2 - 2\times$ *their* **(c)** $\times 6.34\times\cos DBC$
(e)	2.05 to 2.24… nfww	**4**	**M1** for $\sin 31 = \frac{BC}{12.3}$ oe or better or $\sin 41.8[0] = \frac{CD}{16.5}$ oe **M2dep on M1** for $\frac{\text{dist}}{their BC} = \sin(their\ \text{angle}\ CBD)$ or $\frac{\text{dist}}{their CD} = \sin(their\ \text{angle}\ CDB)$ or **M1** for recognition of shortest distance

Question 71

(a)(i)	311 or 311.0 to 311.1	**3**	**M2** for $11 \times 11 + 2 \times \frac{1}{4} \times \pi \times 11^2$ oe or **M1** for [2 ×] $\frac{1}{4} \times \pi \times 11^2$ or 11×11 oe
(a)(ii)	78.6 or 78.55 to 78.56...	**3**	**M2** for $4 \times 11 + 2 \times \frac{1}{4} \times 2 \times \pi \times 11$ oe or **M1** for [2 ×] $\frac{1}{4} \times 2 \times \pi \times 11$ or 4×11 oe
(b)	35.2 or 35.3 or 35.239… to 35.28	**4**	**M3** for [tan =] $\frac{7}{\sqrt{7^2+7^2}}$ or [sin =] $\frac{7}{\sqrt{7^2+7^2+7^2}}$ or [cos =] $\frac{\sqrt{7^2+7^2}}{\sqrt{7^2+7^2+7^2}}$ OR **M2** for $AG = \sqrt{7^2+7^2+7^2}$ or for $\sqrt{7^2+\left(\frac{7}{\sin 45}\right)^2}$ oe or for $AC = \sqrt{7^2+7^2}$ or $\frac{7}{\sin 45}$ oe OR **M1** for $7^2 + 7^2$ or for implicit trigonometry or identifying correct angle

Question 72

'(a)	Cubic	**1**	
(b)(i)	Correct sketch  	**2**	**B1** for one branch correct or an attempt at the correct shape Maximum 1 mark if sketch crosses x-axis or y-axis
(b)(ii)	$\pm\frac{1}{2}$ **nfww**	**2**	**M1** for $4x^2 = 1$ oe or **B1** for $\frac{1}{2}$ or $-\frac{1}{2}$ nfww
(c)(i)	Correct sketch through (0, 0) (180, 0) and (360, 0) with max and min at 1 and –1 resp.  	**2**	**B1** for correct sine curve shape, starting at the origin, with minimum of 1 cycle.
(c)(ii)	199.5 or 199.47... and 340.5...	**3**	**B2** for one correct or **M1** for $\sin x = -\frac{1}{3}$ oe If 0 scored, **SC1** for two reflex angles with a sum of 540 or 2 non-reflex angles with a sum of 180

Question 73

(a)(i)	2[.00] or 2.002 to 2.003 nfww	**3**	**M2** for $\sqrt{4.8^2 + 5.6^2 - 2 \times 4.8 \times 5.6 \times \cos 20.4}$ OR **M1** for $4.8^2 + 5.6^2 - 2 \times 4.8 \times 5.6 \times \cos 20.4$ **A1** for 4.01[17…] or 4.012
(a)(ii)	4.1[0] or 4.11 or 4.100 to 4.107 cao	**2**	**M1** for $\tan 64 = \frac{AX}{their\ \textbf{(a)(i)}}$ or for $\frac{AX}{\sin 64} = \frac{their\ \textbf{(a)(i)}}{\sin(90-64)}$ oe
(a)(iii)	6.96	**2**	**M1** for $\frac{1}{2} \times 4.8 \times 2.9$ oe
(b)	11.3 or 11.31..	**5**	**M4** for $2 \times \frac{8}{\sin(45)} \times \sin 30$ or **B4** for $PM = 5.65[685...]$ or 5.66 or better OR **B1** for *angle RPM* = 45° **M2** for $\frac{8}{\sin(their\ 45)} \times \sin 30$ or **M1** for implicit form

Question 74

246	**3**	**B2** for *BCS*(outh) = 66 or *BCA* = 48 **and** *ACN*(orth) = 66 or *BCW*(est) = 24 or *ACS*(outh) = 114 or **B1** for *ABC* = 66 or *BAC* = 66 or *BCA* = 48 or *ACN*(orth) = 66

Question 75

(a)	13.9 or 13.85 to 13.86	**4**	**M3** for $2x^2 = 28^2 - 20^2$ or better or $x = \left(\sqrt{28^2 - 20^2}\right)\sin 45$ oe or **M2** for $x^2 + x^2 + 20^2 = 28^2$ oe or $\sin 45 = \frac{x}{\sqrt{28^2 - 20^2}}$ or **M1** for any correct Pythag in 2D or *their AC* × sin 45 oe dep on trig/Pythagoras attempt for *AC*
(b)	51.9 or 51.87 to 51.88	**4**	**M3** for $\sin = \frac{29 \text{ to } 30}{37 + 0.5}$ or $\frac{30 - 0.5}{37 \text{ to } 38}$ oe or **M2** for correct trig statement for correct angle with values in range 29 to 31 and 36 to 38 or **M1** for 30 + 0.5 or 30 – 0.5 or 37 + 0.5 or 37 – 0.5 seen or for identifying correct angle *RKM*

Question 76

(a)	Angle $CAB = 52$	**B1**	
	$180 - 52 - \sin^{-1}\left(\frac{60\sin their 52}{87}\right)$	**M3**	**M2** for $[\sin[...]=]\ \frac{60\sin their 52}{87}$ oe or **M1** for $\frac{60}{\sin B}=\frac{87}{\sin their 52}$ oe
	95.08…	**A1**	
(b)	77.1 or 77.08 to 77.11	**6**	**B4** for dist travelled = 256.9 to 257[.0…] or **B3** for [AB =] 109.9 to 110[.0…] or **M3** for $60 + 87 + \sqrt{60^2 + 87^2 - 2\times 60\times 87\times\cos 95.1}$ oe or **M2** for $\sqrt{60^2 + 87^2 - 2\times 60\times 87\times\cos 95.1}$ oe or $AB^2 = 12093.\ldots$ to $12097.\ldots$ or $\frac{87\sin 95.1}{\sin their 52}$ oe or **M1** for $AB^2 = 60^2 + 87^2 - 2\times 60\times 87\times\cos 95.1$ oe or $\frac{\sin 95.1}{AB}=\frac{\sin their 52}{87}$ oe **M1** for *their* total distance $\div 3\frac{20}{60}$ oe

Question 77

(a)(i)	$\frac{(x+3)(2x+5)}{2} = 60$	**M1**	Accept $(x + 3)(2x + 5) = 2 \times 60$ or 120 Accept e.g. $(x + 3)(x + 2.5) = 60$ without division by 2 shown for M1 (but not A1)
	$2x^2 + 6x + 5x + 15$ seen	**B1**	Accept $2x^2 + 11x + 15$ seen
	$2x^2 + 11x - 105 = 0$	**A1**	Correct completion after M1B1 with the fraction seen removed with no errors or omissions seen
(a)(ii)	$(2x + 21)(x - 5)$ [= 0]	**M2**	**M1** for partial factors $2x(x - 5) + 21(x - 5)$ [= 0] or $x(2x + 21) - 5(2x + 21)$ [= 0] OR $(2x + a)(x + b)$ [= 0] where $ab = -105$ or $2b + a = 11$
	–10.5 and 5	**B1**	
(a)(iii)	61.9 or 61.92 to 61.93	**3**	**M2** for $\tan = \frac{2 \times their\,5 + 5}{their\,5 + 3}$ oe or **B1FT** for $2 \times$ *their* 5 + 5 and *their* 5 + 3
3(b)(i)	28.1 or 28.07 to 28.08	**1**	**FT** *their* 90 – *their* **(a)(iii)** unless *their* **(a)(iii)** < 45, in which case FT *their* **(a)(iii)**
3(b)(ii)	10	**3**	**M2** for $(their\,5 + 3) \times \sqrt{\frac{93.75}{60}}$ oe or **M1** for $\sqrt{\frac{93.75}{60}}$ or $\sqrt{\frac{60}{93.75}}$ oe seen or $\left(\frac{their5 + 3}{x}\right)^2 = \frac{60}{93.75}$ oe

Question 78

(a)(i)	96	**2**	**M1** for $\frac{1}{2} \times 24 \times 8$
(a)(ii)	18.4 or 18.43...	**2**	**M1** for $\tan[x] = \frac{8}{24}$ oe

Question 79

(a)	$[\sin =]\dfrac{145}{\frac{1}{2}\times 6.4\times 5.7\times 15}$	**M2**	**M1** for $145 = \frac{1}{2}\times 6.4\times 5.7\times \sin x\times 15$ oe or for $\dfrac{1}{2}\times 6.4\times h\times 15 = 145$ and $\sin x = \dfrac{h}{5.7}$
	32.0[0]	**A1**	If M0, **SC1** for $145 = 0.5\times 6.4\times 5.7\times sin32\times 15$ oe
(b)	3.4[0] or 3.402 to 3.403 nfww	**3**	**M2** for $\sqrt{6.4^2+5.7^2-2\times 6.4\times 5.7\times\cos(32)}$ OR **M1** for $6.4^2+5.7^2-2\times 6.4\times 5.7\times\cos(32)$ **A1** for 11.6 or 11.57 to 11.58
(c)	3.02 or 3.020 to 3.021	**3**	**M2** for $\sin(32)=\dfrac{x}{5.7}$ $\sqrt{80^2+50^2-2\times 80\times 50\times\cos 75}$ or **M1** for recognition that the line from E is perpendicular to AB e.g. right angle seen or $\dfrac{1}{2}\times 6.4\times h$
(d)	10.8 or 10.9 or 10.84 to 10.85...	**4**	**M3** for $[\sin =]\dfrac{their\,(c)}{\sqrt{15^2+5.7^2}}$ or $[\tan =]\dfrac{their\,(c)}{\sqrt{(5.7\times cos32)^2+15^2)}}$ or **M2** for $15^2+5.7^2$ or $(5.7\times\cos 32)^2+15^2$ oe or **M1** for recognition of correct angle
(e)	136 or 136.0...	**3**	**M2** for $938\times 145\times\dfrac{1000}{1000000}$ oe or **M1** for figs 136 or 13601

Question 80

(a)	0, –1.5 oe, –2.8	**3**	**B1** for each
(b)	Correct graph	**4**	**B3 FT** for 10 or 11 correct points FT *their* table or **B2 FT** for 8 or 9 correct points FT *their* table or **B1 FT** for 6 or 7 correct points FT *their* table
(c)	65 to 67	**1**	**FT** intersection of *their* graph with $y = -2$
(d)	$y = 2 - \frac{x}{40}$ oe ruled	**M2**	**M1** for $[y =] 2 - \frac{x}{40}$ oe soi or for $3\cos 2x = 2 - \frac{x}{40}$ oe soi
	32 to 36	**B1**	

Question 81

(a)(i)	21.5 or 21.52...	**2**	**M1** for $\tan(\ldots) = \frac{2.8}{7.1}$ oe
(a)(ii)	10.2 or 10.17 to 10.18	**3**	**M2** for $\left(\frac{2.8}{\tan 21}\right)^2 + 7.1^2$ oe or **M1** for $\frac{2.8}{PR} = \tan 21$ oe
(b)	76.5 or 76.52 to 76.53	**3**	**M2** for $[\sin =] \frac{16.7 \sin 32}{9.1}$ oe or **M1** for $\frac{9.1}{\sin 32} = \frac{16.7}{\sin M}$ oe
(c)(i)	$\frac{1}{2} \times 12.3 \times 21.5 \sin(\ldots) = 62.89$ or better	**M1**	
	28.40 to 28.41…	**A1**	
(c)(ii)	12.2 or 12.17 to 12.18	**3**	**M2** for $\sqrt{12.3^2 + 21.5^2 - 2 \times 12.3 \times 21.5 \times \cos 28.4}$ OR **M1** for $12.3^2 + 21.5^2 - 2 \times 12.3 \times 21.5 \times \cos 28.4$ **A1** for 148 or 148.2 to 148.3
(c)(iii)	6.6[0] to 6.62	**3**	**M2** for $21.5\cos 28.4 - 12.3$ or **M1** for $21.5\cos 28.4$

Question 82

11.9 or 11.91 to 11.92		**7**	**B5** for $t = 1.055$ or 1.0550... **M1** for $\tan w = \frac{their\ t}{5}$ oe OR **M1** for $(2t+3)^2 = t^2 + 5^2$ oe seen isw **M2** for $3t^2 + 12t - 16[=0]$ oe seen isw or **B1** for $4t^2 + 6t + 6t + 9$ **M1FT** for $\frac{-12 \pm \sqrt{12^2 - 4(3)(-16)}}{2(3)}$ oe **M1** for $\tan w = \frac{their\ t}{5}$ oe

Question 83

(a)	27.3 or 27.32 to 27.33	**5**	**M4** for $\tan[\angle ACD] = \frac{83.2}{\frac{83.2}{\tan 38} + 54.5}$ oe or **M3** for $[AC =] \frac{83.2}{\tan 38} + 54.5$ oe or for $[CD =] \sqrt{54.5^2 + \left(\frac{83.2}{\sin 38}\right)^2 - 2(54.5)\left(\frac{83.2}{\sin 38}\right)\cos(180-38)}$ oe or **M2** for $[AB =] \frac{83.2}{\tan 38}$ oe or for $[BD =] \frac{83.2}{sin38}$ oe or **M1** for $\tan 38 = \frac{83.2}{AB}$ oe or $\sin 38 = \frac{83.2}{BD}$ oe
(b)	Centre marked at midpoint of FG. and **Angle** in a **semi-circle** is **90**	**B2**	**B1** for marking the centre at mid-point of FG

(c)	10.8 or 10.81 to 10.82	7	**B2** for 72 or **M1** for $\frac{180}{4+5+6}$ [× 6] and, for triangle PQR **B4** for [angle R=]82.8 or 82.81 to 82.83 or **B3** for [cos$R$ =] $\frac{5}{40}$ oe or better or **M2** for $\frac{4^2+5^2-6^2}{2\times4\times5}$ or **M1** for $6^2 = 4^2 + 5^2 - 2\times4\times5\times\cos R$ After **0** scored for triangle PQR, **SC1** for [P =] 55.8 or 55.77 to 55.78 or [Q =]41.4 *or* 41.40 *to* 41.41

Question 84

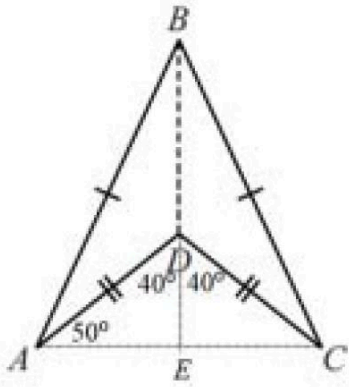
(a)	15[.0] or 15.00 to 15.01	3	**M2** for $\frac{17.2}{\sin 68}\times\sin 54$ oe or **M1** for $\frac{\sin 54}{AC}=\frac{\sin 68}{17.2}$ oe
(b)	15.7 or 15.65 to 15.66	3	**M2** for $\sqrt{their15^2+12.8^2-2\times their15\times12.8\times\cos 68}$ OR **M1** for $their15^2+12.8^2-2\times their15\times12.8\times\cos 68$ **A1** for 244.9 to 245.2
(c)	13.9 or 13.90 to 13.92	3	**M2** for $\frac{x}{17.2}=\sin 54$ oe or $\frac{x}{their15}=\sin 68$ oe or **M1** for distance required is the perpendicular from A to BC soi

Question 85

(a)	$\frac{3}{10} \times 360$ oe	**M2**	**M1** for $\frac{3}{3+7} = \frac{x}{360}$ or for $\frac{x}{360}$ [$\times 2\pi r$] $= \frac{3}{7} \times \frac{360-x}{360}$ [$\times 2\pi r$] oe or better or 1 [$\times 2\pi r$] $= \frac{10}{7} \times \frac{360-x}{360}$ [$\times 2\pi r$] oe or better or $\frac{360}{7+3} \times k$ ($k = 1$ or 7)
	108	**A1**	
(b)(i)	$\frac{1}{2}r^2 \sin y = \frac{1}{2} \times \frac{y}{360} \times \pi r^2$ or $\frac{y}{360} \times \pi r^2 = [2 \times \frac{1}{2}]\, r^2 \sin y$ and one further step leading to $360\sin y = \pi y$ with no errors	**2**	**M1** for $\frac{y}{360} \times \pi r^2$ or for $\frac{1}{2}r^2 \sin y$
(b)(ii)	341.18 or 341.22 341.00 341.49 or 341.54	**3**	**B1** for each
(b)(iii)	108.6 cao	**1**	

Question 86

(a)	4.27 or 4.272...	**2**	**M1** for $4^2 + 1.5^2$ oe
(b)	203 or 202.6…	**3**	**B2** for [angle at W =] 22.6... or for [angle at V =] 67.4 or 67.38… or **M1** for tan = $\frac{5}{12}$ or $\frac{12}{5}$ oe

(c)	25.2 or 25.20 to 25.21[0]  	5	**B4** for [*BC* or *AB* =] 7.6[0] or 7.604 to 7.605 OR **M3** for a complete explicit method leading to *AB* or *BC*, e.g. $\frac{5\sin 140}{\sin 25}$ OR **M2** for a complete implicit method leading to *AB* or *BC*, e.g. $\frac{\sin 25}{5}=\frac{\sin 140}{BC \text{ or } AB}$ oe and **M1** (dep on *AB* from trig) for 2 × *their AB* + 10 OR **B1** for any relevant angle E.g. ∠*BDA* or ∠*BDC* = 140, ∠*DAE* or ∠*DCE* = 50 or ∠*ADE* or ∠*CDE* = 40 or ∠*ADC* = 80
(d)	79.5 or 79.6 or 79.54 to 79.55...	5	**B2** for [PR^2 =] 245 or 245.1 to 245.2 or [*PR* =] 15.65 to 15.66 or 15.7 or **M1** for [PR^2 =] $11^2 + 8^2 - 2 \times 11 \times 8 \times \cos 110$ **M2** for [cos*PQR* =] $\frac{10^2+14^2-(\text{their } PR)^2}{2\times 10\times 14}$ oe or **M1** for (*their* PR)^2 = $10^2 + 14^2 - 2 \times 10 \times 14\cos PQR$ oe

Question 87

(a)	$\sqrt{10.4^2 + 6.5^2 - 2\times10.4\times6.5\times\cos 64}$	**M2**	**M1** for $10.4^2 + 6.5^2 - 2\times 10.4 \times 6.5 \times \cos 64$ **A1** for 91.1 to 91.2
	9.546 to 9.547	**A1**	
(b)(i)	$180 - (26 + 42)$	**B1**	
(b)(ii)	6.89 or 6.888 to 6.892...	**3**	**M2** for $\frac{9.55}{\sin 112} \times \sin 42$ oe or **M1** for $\frac{\sin 112}{9.55} = \frac{\sin 42}{CD}$ oe
(c)	5.84[2…]	**3**	**M2** for $\frac{x}{6.5} = \sin 64$ oe or **M1** for identifying shortest distance from D is perpendicular to AB

Question 88

(a)	245	**1**	
(b)(i)	180 – (55 + 25) [=100]	**M1**	
(b)(ii)	$\frac{32 \times \sin 25}{\sin 100}$ oe	**M2**	**M1** for $\frac{\sin 25}{BH} = \frac{\sin 100}{32}$ oe
	13.73…	**A1**	
(c)	258 or 257.9 to 258.0…	**5**	**B4** for 67.9 to 68.0… OR **M2** for [cos =] $\left(\frac{11^2 + 13.7^2 - 14^2}{2\times13.7\times11}\right)$ **A1** for 0.3738 to 0.376 or **M1** for $14^2 = 11^2 + 13.7^2 - 2\times 11 \times 13.7 \times \cos B$ **M1dep** on at least M1 for 190 + *their* angle B

(d)(i)	2 44 pm or 14 44 cao	**4**	**B3** for 1 hour 44 or 1 hour 43.6 to 1 hour 43.8 or 104 or 103.6 to 103.8 or **B2** for 1.727 to 1.73 or **M2** for $\frac{32}{10\times1.852}\times60$ or **M1** for $32 \div (10 \times 1.852)$
(d)(ii)	7.857 to 7.88	**3**	**M2** for $\frac{x}{13.7}=\cos 55$ oe or **M1** for dist to H occurs when perpendicular from B meets CH soi