Trigonometry & Bearing – Paper 4 – Mark Scheme

Question 1

5 (a)	200.5… to 201	www 2	2	**M1** for $0.5 \times 24 \times 26 \sin 40$ oe **A1**
(b)	17.2 (0….)	www 4	4	**M2** for $26^2 + 24^2 - 2 \times 26 \times 24 \cos 40$ **or M1** for $\cos 40 = \frac{26^2 + 24^2 - BD^2}{2 \times 24 \times 26}$ **A2 or A1** for 295.976..
(c)	12.8 (12.77…)	www 4	4	**B1** for Angle $C = 110$ soi accept on diagram **M2** for $(BC) = \frac{24 \sin 30}{\sin 110}$ oe **or** **M1** $\frac{\sin 110}{24} = \frac{\sin 30}{BC}$ oe i.e. a correct implicit statement soi **A1**
(d)	8.208 to 8.230	www 2	2	**M1** for their **(c)** × sin40 oe

Question 2

5 (a)	(cos) $\frac{180^2 + 115^2 - 90^2}{2 \times 180 \times 115}$	M2	**M1** for correct implicit expression $90^2 =$ ……
	24.98 – 24.99	A2	**A1** for (cos) = 0.9064…
(b) (i)	125(.0….) ft	1**ft**	**ft** 150 – their **(a)**
(ii)	305(.0….) ft	1**ft**	**ft** 180 + their **(b)(i)**
(c)	180sin (54.98 to 55) or 180cos (35 to 35.02) oe or 180sin (360 – their **(b)(ii)**) or 180cos(their **(b)(i)** – 90) oe	M2	**B1** for 54.98 to 55 or 35 to 35.02 soi in correct position. Provided either angle is acute
	147(.4….) cao www 3	A1	
(d)	$\frac{90 \sin 30}{\sin 70}$	M2	**M1** for $\frac{TR}{\sin 30} = \frac{90}{\sin 70}$ or other correct implicit equation
	47.9 (47.88 – 47.89) cao www 3	A1	
(e)	2 000 000 oe	2	Allow 1 : 2 000 000 as answer. **SC1** figs 2 in answer which could be a ratio.

Question 3

2 (a)	5.83 (5.830 to 5.831)	2	**M1** for $3^2 + 5^2$ Any other method must be complete
(b)	113. 6 (114 or 113.5 to 113.6) www 4	4	**M2** for $(\cos C) = \dfrac{5^2 + 8^2 - 11^2}{2 \times 5 \times 8}$ **or M1** for correct implicit expression **A2** (**A1** for –0.4 or $-\dfrac{2}{5}$)
(c)	25.8 (25.77 to 25.85) cao www 3	3	**M1** for 0.5 × 5 × 8 × sin (their angle *C*) o.e must be full method e.g. Hero's formula. **M1** for 0.5 × 3 × 5 oe

Question 4

6	**(a) (i)** 13 cao www	2	**M1** for $\dfrac{PQ}{19.5} = \dfrac{11}{16.5}$ oe or sf = 2/3 or 1.5 seen or correct trig
	(ii) 10.39 to 10.4 www	3	**M2** for $\sqrt{19.5^2 - 16.5^2}$ or explicit trig or **M1** for $x^2 + 16.5^2 = 19.5^2$ or implicit trig
	(iii) 57.76 to 57.81 www	2	**M1** for $\sin = \dfrac{16.5}{19.5}$ oe
	(iv) 655 to 655.4	2	**M1** for $0.02 \times (32)^3$
	(b) (i) 163.5 to 164 www	4	**M2** for $67^2 + 105^2 - 2 \times 67 \times 105\cos 143$ or **M1** for implicit form **A1** for 26732 to 26896
	(ii) 100.8 to 100.9 or 101 www	4	**B1** for (DEF =) 78° May be on diagram and **M2** for $\dfrac{105 \times \sin 70}{\sin \text{their } 78}$ provided their 78 ≠ 32 or 70 or **M1** for $\dfrac{EF}{\sin 70} = \dfrac{105}{\sin \text{their } 78}$ oe their 78 ≠ 32 or 70

Question 5

6	**(a) (i)** $5480^2 + 3300^2 - 2 \times 5480 \times 3300 \times \cos 165$	M2	(75 856 005) **M1** for implicit version
	8709.5..	E2	If E0, **A1** for 75800000 to 75900000
	(ii) $(\sin L =) \frac{\sin 165}{8710} \times 3300$ (0.09806…)	M2	**M1** for $\frac{\sin L}{3300} = \frac{\sin 165}{8710}$ oe (allow 8709.5.) Could use cosine rule using 8710 or better – **M2** for explicit form or **M1** for implicit form (allow 5.6 to 5.63 for A mark)
	5.6 (5.62 to 5.63)	A1	www3
	(b) 22 35 or 10 35 pm	2	Accept 22 35 pm **B1** for 15 35 or 3 35 pm seen or answers 22h 35 mins or (0)8 35(am) or 10 35(am)
	(c) 8710 ÷ 800	M1	
	10.88 to 10.9 with no conversion to h/min or 10 (hrs) 52 (mins) to 10 (hrs) 54 (mins) oe	A1	Implied by correct final ans 2hrs 52 mins if not shown
	13 hrs 45 mins – their time in hrs and mins oe or 13.75 – their decimal time **and** a correct conversion to hrs and mins or minutes	M1	Dep on first **M1** e.g. 13 hrs 45mins – 11 hrs 29 mins or 13.75 – 10.9 then 2hrs 51 mins
	2 hr 52 mins cao	A1	www4 (2 hrs 51.75 mins)

Question 6

2	**(a)** $(\cos Q =) \frac{4^2 + 4.5^2 - 7^2}{2 \times 4 \times 4.5}$ o.e.	M2	**M1** for $7^2 = 4^2 + 4.5^2 - 2 \times 4 \times 4.5 \times \cos(Q)$
	110.74….	E2	If **E0** then **A1** for – 0.354(1….)
	(b) $(RS =) \frac{7 \sin 40}{\sin 85}$	M2	**M1** for $\frac{RS}{\sin 40} = \frac{7}{\sin 85}$ o.e.
	4.516 …	E1	Can be implied by second M
	(c) Angle $R = 55°$	B1	(May be seen on diagram)
	$0.5 \times 7 \times 4.52 \times \sin$(their 55) o.e.	M1	(12.95 – 13.0) their 55 is (180 – 40 – 85)
	$0.5 \times 4 \times 4.5 \times \sin 110.7$ o.e.	M1	(8.418 – 8.42) ($s = 7.75$)
	Triangle PRS + Triangle PQR	M1	Dependent on M1, M1
	21.4 (21.36 – 21.42)	A1	www 5

Question 7

1 (a)	**(i)** $\frac{1380}{62+53}\times 62$	1	Allow 115 for 62 + 53
	(ii) 7.27 (7.271 to 7.272)	1	
	(iii) 42	2	M1 for $\frac{3150}{75}$ oe
(b)	**(i)** 235	3	B2 for angle $ACS = 55$ or angle $ACN = 125$ B1 for 55 seen
	(ii) 12.6 (12.58 to 12.59)	3	M2 for $\frac{4}{6}\times 18.9$ or $4+4+2\times 4\times\cos 55$ or $4+4+2\times 4\times\sin 35$ oe (M1 for $\frac{4}{6}$ soi or $2\times 4\times\cos 55$ or $2\times 4\times\sin 35$ soi oe)
(c)	1500	3	M2 for $\frac{1380}{1-0.08}$ oe (M1 for recognition that 92% = 1380)

Question 8

4 (a)	**(i)** $(\cos(HFG)) = \frac{6^2+14^2-12^2}{2\times 6\times 14}$	M2	M1 for implicit form
	58.4 (58.41…)	A2	A1 for 0.5238…
	(ii) 0.5 × 6 × 14 × sin (their 58.4) oe	M1	ft their **(i)**
	35.8 or 35.77 to 35.78	A1**ft**	Correct or ft their **(i)**
(b)	$(\sin(RQP)) = \frac{\sin(117)\times 12}{18}$	M2	M1 for implicit form
	36.4 or 36.44...	A1	

Question 9

2 (a)	3.02 (3.023…) www 4	4	M3 for $\sqrt{2^2+1.5^2+1.7^2}$ oe may be in two steps or $\sqrt{9.11 \text{ to } 9.15...}$ (3.018 to 3.026..) or M2 for $2^2 + 1.5^2 + 1.7^2$ oe implied by 9.11 to 9.15…. or M1 for any correct Pythag in 1 of the faces e.g. $2^2 + 1.5^2$
(b)	34.1 to 34.3 cao www 3	3	M2 for sin = 1.7/their *EC* or cos = their *EG*/their *EC* or tan = 1.7/their *EG* or complete long method (M1 for *CEG* as required angle – accept on diagram if clear)
(c)	**(i)** 2.95 cao	1	
	(ii) Yes **and** because their **(c)(i)** < their **(a)**	1**ft**	ft their **(a)** and their **(c)(i)**, must say yes or no oe and compare the two distances – numerically or by labels

Question 10

3 (a)	**(i)** 142 to 150	2	B1 for 7.1 to 7.5 seen
	(ii) (0)59 to (0)63	1	
	(iii) 148° to 152° drawn	1	Both marks available from the position of B as lines don't need to be drawn.
	Distance 6.8 to 7.2 cm drawn	1	
	(iv) 328 to 332°	1	
	(v) 60 www 2	2	M1 for 20^2 or better seen
(b)	667 (666.6 to 666.7) www 3	3	B1 for 2.25 (h), 135 (mins), 8100 (sec) and M1 for 1500 ÷ their time in hours (time must be in range 2.09 to 3.25) (could be implied by 697 to 698)
(c)	$(\cos =) \dfrac{1125^2 + 790^2 - 1450^2}{2 \times 1125 \times 790}$	M2	M1 for $1450^2 = 1125^2 + 790^2 - 2 \times 1125 \times 790\cos Q$
	96.9 (96.87 to 96.88) www 4	A2	A1 for (cos =) –0.1197…(which implies M2)

Question 11

6	**(a)** $120^2 + 95^2 - 2 \times 120 \times 95 \times \cos 77$	**M2**	**M1** for implicit version
	135.26 … or 135.3	**E2**	**A1** for 18295 to 18297
	(b) $(\sin B) = \dfrac{\text{their}135 \times \sin 26}{79}$	**M2**	**M1** for $\dfrac{\sin B}{\text{their}135} = \dfrac{\sin 26}{79}$ oe
	48.5 to 48.7 isw	**A1**	
	131 or 131.3 to 131.5 www4	**B1ft**	ft for 180 – their 48.5 to 48.7 dep on sine rule or sine used
	(c) (Angle A =) 22.5 to 22.7	**B1ft**	ft 154 – their **(b)**, also accept angle B = 67.3 to 67.5 (ft their **(b)** – 64)
	'Path'/79 = sin (their A) oe	**M1**	Dep on **B1** and their $A < 90$ eg 79 cos 67.4
	30.2 to 30.5 www3	**A1**	
	(d) $\frac{1}{2} \times 120 \times 95 \times \sin 77$ oe	**M1**	(5554)
	Their area ÷ 180	**M1**	Dep on area attempt
	30.8 to 30.9	**A1**	
	30	**B1ft**	ft their 30.8 to 30.9 truncated dep on at least **M1** earned After **M2** answer 30 www scores **A1B1** Answer 30 ww scores 0

Question 12

8	**(a) (i)** $3^2 + 5^2 - 2 \times 3 \times 5 \cos 45$ 3.575… or 3.576 cao	**M2** **E2**	**M1** for correct implicit version **A1** for 12.78 to 12.8
	(ii) 36.3 to 36.4	**3**	**M2** for $(\sin BCA =) \frac{3 \times \sin 45}{\text{their } 3.58}$ or **M1** for $\frac{\sin BCA}{3} = \frac{\sin 45}{\text{their } 3.58}$ oe
	(b) (i) 76	**B1**	
	(ii) 17.4 or 17.42 to 17.44	**3**	**M2** for $0.5 \times 3 \times 5 \times \sin 45 + 0.5 \times 5 \times 5 \sin$ their **(b)(i)** 5.3033... + 12.1286... or **M1** for $0.5 \times 3 \times 5 \times \sin 45$ or $0.5 \times 5 \times 5 \sin$ their **(b)(i)**
	(c) 48.2 (48.18 to 48.19)	**2**	**M1** for $\cos PAB = \frac{2}{3}$ oe

Question 13

2 (a)	10.9 or 10.92… www 4	**4**	**M2** for $4^2 + 9^2 - 2 \times 4 \times 9 \times \cos 108$ If **M0**, **M1** for correct implicit statement **A1** for 119.249...(which can be 3 www)
(b) (i)	5.16 or 5.162….. www 3	**3**	**M2** for $9 \times \cos 55$ oe in correct triangle If **M0**, **B1** for 55 or 35 in correct position soi
(ii)	(0)53	**B2**	**SC1** for answer 233

Question 14

(c)	$11 \div \cos 50$ soi by 17.(11…) oe	**M2**	**M1** for $\cos 50 = \frac{11}{AC}$ oe i.e. implicit
	(their AC)$^2 + 31^2 -$ $2 \times$ their $AC \times 31 \cos 100$	**M2**	**M1** for implicit cos rule
	art 37.9 cao www 6	**A2**	**A1** for 1433 to 1443

Question 15

2 (a)	$[\sin =]\frac{10\sin 95}{12}$ 56.1 (56.11 to 56.12) www 3	**M2** **A1**	**M1** for correct implicit equation
(b)	$12^2 + 17^2 - 2 \times 12 \times 17\cos 30$ oe 8.93 [8.925….] www 4	**M2** **A2**	**M1** for correct implicit equation **A1** for 79.66 to 79.67 or 79.7
(c) (i)	126 or 126.1 (126.11 to 126.12)	**1ft**	ft their (a) + 70 [provided less than 360]
(ii)	306 or 306.1 (306.11 to 306.12)	**1ft**	ft 180 + their (c)(i) [provided less than 360]
(d)	$[\sin =]\frac{17\sin 30}{their(b)}$ oe or $[\cos =]\frac{12^2 + (their(b)^2 - 17^2}{2\times 12\times their(b)}$ oe 180 – 95 – their (a) 137 [136.5 to 136.9] www 4	**M2** **M1** **A1**	**M1** for correct implicit equation [107.7 to 107.9 or 108 or 72 or 72.1 to 72.3] e.g. 28.88 to 28.9 seen – may be on diagram Alt methods possible e.g. $[\sin ABC =]\frac{12\sin 30}{their(b)}$ [42.2...] gets **M1** then 360 – 95 – 30 – their (a) – their 42.2 gets **M2** dep on previous **M1** isw reflex angle 223 or 223.1 to 223.5 after correct answer seen

Question 16

2	**(a) (i)** $[\cos A=]\frac{32^2 + 64^2 - 43^2}{2\times 32\times 64}$	**M2**	**M1** for correct implicit version $43^2 = 32^2 + 64^2 - 2\times 32\times 64\cos A$
	37.00[...]	**A2**	**A1** for $\frac{3271}{4096}$ or 0.798 to 0.799
	(ii) 616 or 616.2 to 616.4…	**2**	**M1** for ½ × 32 × 64 × sin 37 oe
	(b) $[\text{Sin } ADC =]\frac{64\sin 55}{70}$ soi by 48.49…rounded or truncated or x^2 –(73.41 to 73.42) x – 804 [= 0]	**M2**	**M1** for correct implicit version of sine rule or cosine rule with x
	$\frac{70\sin(125 - their\,48.5)}{\sin 55}$ or $64^2 + 70^2 - 2 \times 64 \times 70\cos(125 - their\,48.5)$ or solving their 3 term quadratic equation	**M2**	**M1** for implicit sine rule or cosine rule or for one error in quadratic solution Ignore negative solutions
	228 or 228.0 to 228.1 www	**A2**	**A1** for 83.0 to 83.1

Question 17

6	**(a)** sin [ ]= $\frac{130}{0.5\times16\times25}$ oe	**M2**	**M1** for $0.5 \times 16 \times 25 \times \sin[\ ] = 130$ oe but if 40.54… reached from implicit method then **M2**
	40.54... = 40.5	**E1**	Must see 40.54.. and conclusion Use of 40.5 alone in implicit expression scores **M1**.
	(b) 16.51 to 16.53… or 16.5 www	**4**	**M2** for $16^2 + 25^2 - 2 \times 16 \times 25 \times \cos(40.5)$ oe [allow 40.54…] (**M1** for $\cos 40.5 = \frac{16^2+25^2-AC^2}{2\times16\times25}$) [allow 40.54...] **A1** for 272.6 to 273.0…(which implies M2)
	(c) 10.39 to 10.4[0]	**2**	**M1** for $0.5 \times 25 \times$ distance = 130 or $\frac{dist}{16} = \sin[40.5]$ oe [allow 40.54….]

Question 18

Qu.	Answer	Marks	Part marks
6 **(a)**	31.4	**3**	**M2** for $\frac{15.7}{\sin 30}$ or **M1** for correct implicit statement
(b)	$[\sin E =] \frac{15.7 \times \sin 52}{16.5}$	**M2**	**M1** for correct implicit statement
	48.573…	**A1**	
(c) **(i)**	$[\angle ACE =]$ 180 – 52 – 48.57 [= 79.43]	**M1**	
	$[\angle ECD =]$ 40.57…	**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 $0.5 \times 15.7 \times$ *their* 31.4 sin(90 – 30) oe **M1** for 0.5 × 15.7 × 16.5 sin(128 – *their* 48.6 or 48.57) oe **M1** for 0.5 × 16.5 × 23.4 sin (40.6 or 40.57) oe

Question 19

7	**(a)**	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 **SC1** for final answer of $5\sqrt{7}$ or better
	(b) (i)	White = 8.5, red = 11	**5**	**B3** for $7w + 5(w + 2.5) = 114.5$ or for $7(r - 2.5) + 5r = 114.5$ oe **B1** for 8.5 or 11 or **SC2** for $7w + 5 \times w + 2.5 = 114.5$ leading to 9.33[3…] or **SC1** for $7w + 5 \times w + 2.5 = 114.5$ OR **B1** for $r = w + 2.5$ oe **B1** for $7w + 5r = 114.5$ oe **M1** for elimination of a variable **A1** for 8.5 or 11
	(ii) (a)	$\frac{42}{132}$ or $\frac{21}{66}$ or $\frac{14}{44}$ or $\frac{7}{22}$ (0.318 or 0.3181 to 0.3182)	**2**	**M1** for $\frac{7}{12} \times \frac{6}{11}$
	(ii) (b)	$\frac{70}{132}$ or $\frac{35}{66}$ (0.53[0] or 0.5303…)	**3**	**M2** for $\frac{7}{12} \times \frac{5}{11} + \frac{5}{12} \times \frac{7}{11}$ or $1 -$ *their* (a) $- \frac{5}{12} \times \frac{4}{11}$ or **M1** for $\frac{7}{12} \times \frac{5}{11}$ or $\frac{35}{132}$ or **SC1** for $\frac{70}{144}$ oe from replacement

Question 20

6	(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 21

11	(a)	$3^2 + 1^2$	1	Ignore attempt to evaluate $\sqrt{10}$
	(b) (i)	$\frac{\sqrt{10}}{3}$ final answer	1	
	(ii)	$\frac{10}{3}$ final answer	2	**M1** for $their\,\frac{\sqrt{10}}{3}\times\sqrt{10}$ or $their\left(\frac{\sqrt{10}}{3}\right)^2+\left(\sqrt{10}\right)^2$ implied by 3.33 seen
	(c)	$\frac{100}{27}$ or $3\frac{19}{27}$ isw conversion or 3.7[03] to 3.7[04]	2	**M1** for $3\times\left(\frac{\sqrt{10}}{3}\right)^n$ oe where n is 3 or 4 or for $[OP_4 =]\sqrt{\frac{1000}{81}}$ or for their (b)(ii) $\times\left(\frac{\sqrt{10}}{3}\right)^n$ where n is 1 or 2
	(d) (i)	18.43...	2	**M1** for tan $[P_1OP_2]=\frac{1}{3}$ oe
	(ii)	18.4[3…]	1	
	(iii)	20	3	**SC2** for 19 **or M1** for $\frac{360}{18.4[3...]}$

Question 22

4	**(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 $\frac{70\sin(their\,40)}{\sin 32}$ or M1 for correct implicit equation
	(c) **(i)** 4060 or 4063 to 4064 nfww	**3**	**M2** for $\frac{1}{2}(55\times 70\sin 40) + \frac{1}{2}$ $(70\times their(b)\sin(180-their\,40-32))$ 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
	(d) 35.4 or 35.35… nfww	**2**	**M1** for $\sin 40 = \frac{distance}{55}$ or better or for $\frac{1}{2}$ (55 × 70 sin 40) = (70 × distance) ÷ 2 or better

Question 23

2	**(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*) =] $\frac{6.46^2 + 3^2 - 8.6^2}{2\times 6.46\times 3}$ 127 or 126.8…	**M2** **A2**	**M1** for correct cos rule but implicit version **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 24

2	**(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 25

5	**(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
	(e)	Arcs for perp bisector of *SL*	**1**	Two pairs of correct arcs
		Ruled perp bisector of *SL*	**1**	Within tolerance of overlay
		Arcs for bisector of angle *PSL*	**1**	Marks on *PS* and *SL* plus one pair of correct arcs
		Ruled bisector of angle *PSL*	**1**	Within tolerance of overlay
		B marked within accuracy	**1**	Within tolerance of overlay Dep on two correct bisectors drawn
	(f)	3.375	**2**	**M1** for 1.5×1.5^2 or $(2/3)^2$ seen

Question 26

3	(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 27

3	(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 28

7	(a) (i)	**Any two of with conclusion** Angle ACD = angle ABD Angle CAB = angle CDB Angle AXC = angle DXB **AND** 'triangles have equal angles' oe **OR** **All three of without conclusion** Angle ACD = angle ABD Angle CAB = angle CDB Angle AXC = angle DXB	**2**	**B1** for two pairs without a conclusion e.g. similar and AA or AAA
	(ii)	**(a)** 10	**2**	**M1** for $\frac{DX}{12.5} = \frac{3.2}{4}$ oe
		(b) $4^2 + 3.2^2 - 2 \times 4 \times 3.2\cos 110$	**M2**	or **M1** for implicit version
		34.9 to 35	**A1**	Implied by answer 5.92 or 5.915 to 5.916 after **M2**
		5.92 or 5.915 to 5.916	**B1**	
		(c) 58.7 or 58.73[…]	**2FT**	**FT** for ½ × 12.5 × *their* 10 × sin110 oe correctly evaluated to 3 or more sig figs **M1** for ½ × 12.5 × *their* 10 × sin110 oe or ½ × 4 × 3.2 × sin110 × $(12.5/4)^2$ After **0** scored **and** 15.6... in **(a)(ii)(a)**, allow **SC1** for ½ × 4 × 3.2 × sin110 × $(12.5/3.2)^2$
	(b)	7.62 or 7.623 to 7.624	**5**	**B4** for 37.6[2…] or 37.63 or **M2** for $[AB =] \frac{30}{\tan 31}$ or 30 × tan59 oe or **M1** for $\tan 31 = \frac{30}{AB}$ or $\tan 59 = \frac{AB}{30}$ oe **And** **M2** for $[BD =]$ *their* AB × tan37 oe or **M1** for $\tan 37 = \frac{BD}{\text{their } AB}$ oe

Question 29

(c)	15	**4**	**B3** for answer 60 or **M3** for $75 - \sqrt{145^2 - (55^2 + 120^2)}$ oe **M2** for $\sqrt{145^2 - (55^2 + 120^2)}$ oe or **M1** for $\sqrt{55^2 + 120^2}$
(d)	24.4[4..] to 24.45	**3**	**M2** for $\cos^{-1}(\sqrt{55^2 + 120^2}/145)$ oe, e.g. or $\sin^{-1}(75 - \text{their } \mathbf{(c)})/145$ or $\tan^{-1}((75 - \text{their } \mathbf{(c)})/\sqrt{55^2 + 120^2})$ or **M1** for $\cos = \sqrt{55^2 + 120^2}/145$ oe or $\sin = (75 - \text{their } \mathbf{(c)})/145$ or $\tan = (75 - \text{their } \mathbf{(c)})/\sqrt{55^2 + 120^2}$

Question 30

8	**(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 $\frac{x}{39.5} = \sin \textit{their } \mathbf{(b)}$

Question 31

1 (a) (i)	5.37[1...]	**2**	**M1** for $[AD^2 =]\ 2.6^2 + 4.7^2$ oe or better
(ii)	54.1 or 54.11 to 54.12	**3**	**M2** for $\tan [BCD =] \frac{4.7}{(17-11-2.6)}$ oe or **B1** for 3.4 seen
(iii)	65.8	**2**	**M1** for $\frac{11+17}{2} \times 4.7$ oe
(b)	263.2 or 263	**3FT**	**FT** *their* **(a)(iii)** × 4 correctly evaluated **M2** for *their* **(a)(iii)** $\times \left(\frac{9.4}{4.7}\right)^2$ oe or **M1** for [scale factor =] $\left(\frac{9.4}{4.7}\right)^2$ or $\left(\frac{4.7}{9.4}\right)^2$ soi

Question 32

5 (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 $\sin = \frac{4}{\textit{their}\ 4.9}$

Question 33

7	(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 34

6	(a)	$95.5^2 + 83.1^2 - 2 \times 95.5 \times 83.1 \times \cos 101$	**M2**	**M1** for $\cos 101 = \frac{95.5^2 + 83.1^2 - AB^2}{2 \times 95.5 \times 83.1}$
		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..] or **M2** for [sin =] $\frac{83.1 \times \sin 101}{138[.0..]}$ oe or **M1** for correct implicit version After **M0**, **SC1** for angle ABC = 42.76 to 42.8
	(c)	18.8 or 18.79[…]	2	**M1** for $46.2 \times \cos(45 + 21)$ oe After **M0**, **SC1** for answer 42.2 or 42.20 to 42.21

Question 35

3	(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 = $\frac{their TB}{70}$ 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 36

7	(a)	123 to 127	1	
	(b)	288 to 292	1	
	(c)	[1:] 1 000 000	1	
	(d)	Correct ruled perpendicular bisector of *CB* with correct arcs Correct two pairs of arcs	2	**B1** for correct perpendicular bisector without/wrong arcs
		Correct ruled bisector of angle *ACB* with correct pair of arcs	2	**B1** for correct bisector of angle *ACB* without/wrong arcs
		Ruled line parallel to *CB* in triangle	1	Provided this line is not the perpendicular bisector of *AC*
		1.3 to 1.7 cm from *CB* in triangle	1	
		Correct region indicated	1dep	Dependent on at least B1,B1,1,1 earned
	(e)	40	2	**M1** for 0.4×10^2 oe

Question 37

4	(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 $\frac{1.9^2 + 2.3^2 - their 1.6^2}{2 \times 1.9 \times 2.3}$ 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 $\frac{1}{2}\times 1.2\times$ *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 38

5 (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)	2339 oe	**1**	
(ii)	650	**2**	**M1** for 1560 ÷ journey time

Question 39

5 (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 40

5 (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 $510^2 + 720^2 - 2\times510\times720\cos 40$ 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 41

8(a)(i)	290	**2**	**M1** for 180 + 110 oe
8(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

8(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
8(b)(i)	$x(x - 25) = 2200$	**1**	and no errors seen
8(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 42

10(a)	$12.5^2 = x^2 + 8.5^2 - 2 \times x \times 8.5\cos60$ oe isw	**M2**	**M1** for $\cos60 = \frac{x^2 + 8.5^2 - 12.5^2}{2 \times x \times 8.5}$
	$156.25 = x^2 + 72.25 - 8.5x$	**A1**	or better
	$2x^2 - 17x - 168 = 0$	**A1**	with no errors or omissions
10(b)	$\frac{[--]17 \pm \sqrt{([-]17)^2 - 4(2)(-168)}}{2 \times 2}$	**2**	**B1** for $\sqrt{([-]17)^2 - 4(2)(-168)}$ or better seen and if in form $\frac{p + or - \sqrt{q}}{r}$ **B1** for $p = [- -]\ 17$ **and** $r = 2 \times 2$
	14.35, –5.85 final answers	**1, 1**	**SC1** for 14.352 to 14.353 and –5.853 to –5.852 seen or 14.3 or 14.4 and –5.8 or –5.9 as final answers or –14.35 and 5.85 as final answers or 14.35 and –5.85 seen in working
10(c)	12.2 or 12.17… nfww	**3**	**M2** for $\frac{their\,14.35 \times \sin46}{\sin58}$ or **M1** for $\frac{\sin46}{CD} = \frac{\sin58}{their14.35}$
10(d)	138 or 137.5 to 137.8 nfww	**3**	**M1** for $0.5 \times their\ 14.35 \times 8.5\sin60$ **M1** for $0.5 \times their\ 14.35 \times their12.2 \times \sin76$

Question 43

5(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…
5(b)	46.3 or 46.29 to 46.30…	**3**	**M2** for $[\sin OAC =]\frac{7\sin 78}{9.47}$ or **M1** for $\frac{\sin OAC}{7}=\frac{\sin 78}{9.47}$
5(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**	
5(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 44

3(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 $170^2 - 150^2$
3(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 $\frac{181}{300}$
3(c)(i)	28.1 or 28.07…	**2**	**M1** for $\cos = \frac{15}{17}$ oe
3(c)(ii)	331.9 or 331.9…	**2**	**FT** 360 – *their* **(c)(i)** **M1** for 360 – *their* **(c)(i)** oe
3(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 $\frac{1}{2} \times 150 \times \textit{theirCD}$ 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 45

5(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
5(b)	624 or 623.8 to 623.9	**6**	**M2** for $450 - 400 \sin 50$ or **M1** for $\sin 50 = \frac{\ldots}{400}$ **M2** for $350 + 400 \cos 50$ or **M1** for $\cos 50 = \frac{\ldots}{400}$ **M1** for $(\textit{their}\ (450 - 400 \sin 50))^2 + (\textit{their}\ (350 + 400 \cos 50))^2$
5(c)	10 min 8 s	**4**	**B3** for 10.1 or 10.13… or **M2** for $(400 + 350 + 450 + \textit{their DA}) \div 3$ [÷ 60] oe or **M1** for any distance ÷ 3 **M1** for rounding *their* minutes into minutes and seconds to nearest second if clearly seen

Question 46

6(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
6(a)(ii)	292.0 or 291.98 to 291.99	**1**	
6(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
6(b)(i)	15 500 or 15 501 to 15 503. …	**2**	**M1** for $0.5 \times 192 \times 168 \times \sin(106)$ oe
6(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