

Q1.

4	(i)	Use $\tan(A \pm B)$ formula to obtain an equation in $\tan x$ State equation $\frac{\tan x + 1}{1 - \tan x} = 4 \frac{(1 - \tan x)}{1 + \tan x}$, or equivalent Transform to a 2- or 3-term quadratic equation Obtain given answer correctly	M1 A1 M1 A1 [4]
	(ii)	Solve the quadratic and calculate one angle, or establish that $t = \frac{1}{3}, 3$ (only) Obtain one answer, e.g. $x = 18.4^\circ \pm 0.1^\circ$ Obtain second answer $x = 71.6^\circ$ and no others in the range [Ignore answers outside the given range]	M1 A1 A1 [3]

Q2.

4	(i)	State answer $R = 5$ Use trigonometric formulae to find α Obtain answer $\alpha = 53.13^\circ$	B1 M1 A1 3
	(ii)	Carry out, or indicate need for, calculation of $\sin^{-1}(4.5/5)$ Obtain answer 11.0° Carry out correct method for the second root e.g. $180^\circ - 64.16^\circ - 53.13^\circ$ Obtain answer 62.7° and no others in the range [Ignore answers outside the given range.]	M1 A1√ M1 A1√ 4
	(iii)	State least value is 2	B1√ 1

Q3.

2	(i)	Use trig formulae to express LHS in terms of $\cos x$ and $\sin x$ Use correct exact values of $\cos 60^\circ, \sin 60^\circ$, etc. Obtain given answer	M1 M1 A1 3
	(ii)	State or imply answer is $\cos^{-1}(1/\sqrt{3})$ Obtain answer 54.7°	M1 A1 2

Q4.

- 5 (i) State $R = \sqrt{26}$ B1
 Use trig formula to find a M1
 Obtain $\alpha = 11.31^\circ$ with no errors seen A1 [3]
- (ii) Carry out evaluation of $\cos^{-1}\left(\frac{4}{\sqrt{26}}\right)$ ($\approx 38.3288\dots^\circ$) M1
 Obtain answer 27.0° A1
 Carry out correct method for second answer M1
 Obtain answer 310.4° and no others in the range A1√ [4]
 [Ignore answers outside the given range.]

Q5.

- 5 Use $\tan^2 x = \sec^2 x - 1$ or $\sin^2 x = 1 - \cos^2 x$ M1
 Obtain 3-term quadratic in $\sec x$ or $\cos x$, e.g. $2\sec^2 x + \sec x - 6 = 0$ A1
 Make reasonable solution attempt at a 3-term quadratic M1
 Obtain $\sec x = \frac{3}{2}$ and $\sec x = -2$, or equivalent A1
- [or $6\cos^2 x - \cos x - 2 = 0$
 $\cos x = \frac{2}{3}, -\frac{1}{2}$]
- Obtain answer $x = 48.2^\circ$ A1
 Obtain answer $x = 120^\circ$ and no others in the range A1 [6]
 [Ignore answers outside the given range.]

Q6.

- 3 (i) Use $\tan(A \pm B)$ formula to obtain an equation in $\tan x$ M1
 Use $\tan 45^\circ = 1$ and obtain a correct equation in any form A1
 Obtain the given equation correctly A1 [3]
- (ii) Solve the given quadratic in $\tan x$ and evaluate an inverse tangent M1
 Obtain a correct answer, e.g. 18.4° A1
 Obtain second answer, e.g. 26.6° , and no others in the given interval A1 [3]
 [Treat the giving of answers in radians as a misread. Ignore answers outside the given interval.]

Q7.

- 8 (i) Use correct $\sin(A - B)$ and $\cos(A - B)$ formulae M1
 Substitute exact values for $\sin 30^\circ$ etc. M1
 Obtain given answer correctly A1 [3]
- (ii) State $\sqrt{3} \sin x = \frac{1}{2} \sec x$ B1
 Rearrange to $\sin 2x = k$, where k is a non-zero constant M1
 Carry out evaluation of $\frac{1}{2} \sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$ M1
 Obtain answer 17.6° A1
 Carry out correct method for second answer M1
 Obtain remaining 3 answers from $17.6^\circ, 72.4^\circ, 197.6^\circ, 252.4^\circ$ and no others in the range A1 [6]
 [Ignore answers outside the given range]

Q8.

- | | | | |
|----------|--------------|---|---------------------------|
| 8 | (i) | State or imply $R = \sqrt{52}$ or $2\sqrt{13}$
Use appropriate formula to find α
Obtain 56.31° | B1
M1
A1 [3] |
| | (ii) | Attempt to find at least one value of $\theta - \alpha$
Obtain one correct value 80.9° of θ
Carry out correct method to find second answer
Obtain 211.7° and no others in range | M1
A1
M1
A1 [4] |
| | (iii) | Obtain 60, following their value of R
Obtain 8. Allow quoted solution | B1 \checkmark
B1 [2] |

Q9.

- | | | | |
|----------|-----------------|--|--------------------------|
| 8 | (i) | Use $\operatorname{cosec}\theta = \frac{1}{\sin\theta}$ and $\sec\theta = \frac{1}{\cos\theta}$
Attempt to simplify left-hand side
Confirm given right-hand side $4\cos 2\theta$ with no errors seen | B1
M1
A1 [3] |
| | (ii) (a) | State or imply $\cos 2\theta = \frac{3}{4}$
Attempt correct process to find at least one angle
Obtain 20.7°
Obtain 159.3° and no others in range | B1
M1
A1
A1 [4] |
| | (b) | Recognise as $\frac{4\cos 30^\circ}{\sin^2 30^\circ}$
Obtain $8\sqrt{3}$ | B1
B1 [2] |

Q10.

- | | | | |
|----------|-----------------|--|---------------------------|
| 4 | (i) | Use $\sec^2 \theta = 1 + \tan^2 \theta$
Attempt solution of quadratic equation in $\tan \theta$
Obtain $\tan^2 \theta - 12 \tan \theta + 36 = 0$ or equivalent and hence $\tan \theta = 6$ | B1
M1
A1 [3] |
| | (ii) (a) | Attempt use of $\tan(A - B)$ formula
Obtain $\frac{5}{7}$ following their value of $\tan \theta$ | M1
A1 \checkmark [2] |
| | (b) | Attempt use of $\tan 2\theta$ formula
Obtain $-\frac{12}{35}$ | M1
A1 [2] |

Q11.

- 4 (i) State or imply $R = 15$ B1
 Use appropriate formula to find α M1
 Obtain 53.13° A1 [3]
- (ii) Attempt to find at least one value of $\theta - \alpha$ M1
 Obtain one correct value 68.6° of θ A1
 Carry out correct method to find second answer M1
 Obtain 217.7° and no others in range A1 [4]
- (iii) State 15, following their value of R from part (i) B1✓ [1]

Q12.

- 7 (i) State $R = \sqrt{29}$ B1
 Use trig formula to find α M1
 Obtain $\alpha = 21.80^\circ$ with no errors seen A1 [3]
- (ii) Carry out evaluation of $\sin^{-1}\left(\frac{4}{R}\right)$ ($\approx 47.97^\circ$) M1
 Carry out correct method for one correct answer M1
 Obtain one correct answer e.g. 13.1° A1
 Carry out correct method for a further answer M1
 Obtain remaining 3 answers $55.1^\circ, 193.1^\circ, 235.1^\circ$ and no others in the range A1 [5]
- (iii) Greatest value of $10 \sin 2\theta + 4 \cos 2\theta = 2\sqrt{29}$ M1
 $\frac{1}{116}$ A1 [2]

Q13.

- 8 (i) Use correct $\sin(A - B)$ and $\cos(A - B)$ formula M1
 Substitute exact values for $\cos 30^\circ$ etc. M1
 Obtain given answer correctly A1 [3]
- (ii) State $2\operatorname{cosec} x = 3\cot^2 x - 2$ B1
 Use $\cot^2 x = \operatorname{cosec}^2 x - 1$ M1
 Attempt solution of quadratic equation in $\operatorname{cosec} x$ or $\sin x$ M1
 ($3\operatorname{cosec}^2 x - 2\operatorname{cosec} x - 5 = 0$ or $5\sin^2 x = 2\sin x - 3 = 0$)
 Obtain $\sin x = \frac{3}{5}$ or -1 A1✓
- Obtain one correct answer for $\sin^{-1}\left(\frac{3}{5}\right)$ A1
 Obtain remaining 2 answers from $36.9^\circ, 143.1^\circ, 270^\circ$ and no others in the range A1 [6]
 [Ignore answers outside the given range]
 SC If only answer given is 270° B1

Q14.

5	(i) Use relevant formulae for $\cos(x - 30^\circ)$ and $\sin(x - 60^\circ)$ { allow ONE sign error } Use $\sin 30^\circ = \cos 60^\circ = \frac{1}{2}$ and $\sin 60^\circ = \cos 30^\circ = \frac{\sqrt{3}}{2}$ Collect terms and obtain given answer correctly	M1*	⑤
	(ii) Carry out correct processes to evaluate a single trig ratio Obtain answer 73.9° Obtain second answer 253.9° and no others	M1(dep*) A1 M1 A1	3 3
	(iii) State or imply that $\cos^2 x = \frac{1}{13}$ or $\sin^2 x = \frac{12}{13}$ Use a relevant trig formula to evaluate $\cos 2x$ Obtain exact answer $-\frac{11}{13}$ correctly	B1 M1 A1	3 3
[Use of only say $\cos x = +\frac{1}{\sqrt{13}}$, probably from a right triangle, can earn B1M1A0.]			

Q15.

4 (i)	State answer $R = 2$ Use trig formula to find α Obtain answer $\alpha = \frac{1}{3}\pi$	B1 M1 A1	[3]
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(ii)	Carry out, or indicate need for, evaluation of $\cos^{-1}(\sqrt{2}/2)$ Obtain, or verify, the solution $\theta = \frac{7}{12}\pi$ Attempt correct method for the other solution in range i.e. $-\cos^{-1}(\sqrt{2}/2) + \alpha$ Obtain solution $\theta = \frac{1}{12}\pi$: [M1A0 for $\frac{25\pi}{12}$]	M1* A1 M1(dep*) A1	[4]
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Q16.

3	At any stage, state answer $x = 90^\circ$ (c.w.o) Write the equation in the form $6\sin x \cos x = \cos x$ Remove factor of $\cos x$ and solve an equation in $\sin x$ for x Obtain answer $x = 9.59^\circ$ and no others in the range (9.6° OK: rubric) (Ignore answers outside the given range.)	B1 B1 M1 A1	4
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Q17.

8 (i)	State answer $R = \sqrt{2}$ Use trigonometric formulae to find α Obtain answer $\alpha = \frac{1}{4}\pi$ (NOT 45° , unless $45^\circ = \frac{\pi}{4}^c$ somewhere, later)	B1 M1 A1	3
(ii)	Use $\cos \theta + \sin \theta = \sqrt{2} \cos(\theta - \frac{1}{4}\pi)$ to justify the given answer	B1	1
(iii)	Differentiate using the quotient or product rule Obtain derivative in any correct form Obtain the given answer correctly	M1 A1 A1	3
(iv)	Convert integrand to give $\int_{\frac{1}{2}}^1 \sec^2(\theta - \frac{\pi}{4}) d\theta$ Integrate, to obtain function $\frac{1}{2} \tan(\theta - \frac{\pi}{4})$ Substitute (correct) limits correctly, to obtain given result	B1 M1 A1	 3

Q18.

3 (i)	State answer $R = 15$ Use trig formula to find α Obtain $\alpha = 22.62^\circ$	B1 M1 A1	3
(ii)	Carry out evaluation of $\cos^{-1}(\frac{10}{13})$ ($\approx 39.715^\circ$) Obtain answer 17.1° Carry out correct method for second answer Obtain answer 297.7° and no others in the range [Ignore answers outside the given range]	M1 A1 M1 A1	4

Q19.

4 (i)	Use $\tan(A \pm B)$ formula to express LHS in terms of $\tan x$ Obtain $\frac{\tan x + 1}{1 - \tan x} = \frac{1 - \tan x}{1 + \tan x}$, or equivalent Make relevant use of the $\tan 2A$ formula Obtain given answer correctly	M1 A1 M1 A1	4
(ii)	State or imply $2x = \tan^{-1}(2/2)$ Obtain answer $x = 22 \frac{1}{2}^\circ$ Obtain answer $x = 112 \frac{1}{2}^\circ$ and no others in range	M1 A1 A1	3

Q20.

- 6 (i) State answer $R = 17$, allow $\sqrt{289}$ B1
 Use trig formula to find α M1
 Obtain $\alpha = 61.93^\circ$, (1.08 radians) A1 [3]
- (ii) Carry out evaluation of $\sin^{-1}(14/17) \approx 55.44^\circ$, or equivalent M1
 Obtain answer 117.4° , (2.06 radians) A1
 Carry out correct method for second answer M1
 Obtain answer 186.5° and no others in the range (3.255 radians) A1√ [4]
 [Ignore answers outside the given range.]

Q21.

- 4 (i) Use correct $\sin(A+B)$ and $\cos(A+B)$ formulae M1
 Substitute exact values for $\sin 30^\circ$ etc. M1
 Obtain given answer correctly A1 [3]
- (ii) Solve for x M1
 Obtain answer $x = 10.9^\circ$ A1
 Obtain second answer $x = -169.1^\circ$ and no others in the range A1 [3]
 [Ignore answers outside the given range.]

Q22.

- 4 (i) Use trig formulae to express equation in terms of $\sin x$ and $\cos x$ M1
 Use $\cos 60^\circ = \frac{1}{2}$ and $\sin 60^\circ = \frac{\sqrt{3}}{2}$, or equivalent M1
 Obtain equation in $\sin x$ and $\cos x$ in any correct form A1
 Obtain $\tan x = \sqrt{3}/5$, or 0.3464..., or equivalent A1 [4]
- (ii) Obtain answer $x = 19.1^\circ$ B1
 Obtain answer $x = 199.1^\circ$ and no others in the range B1√ [2]
 [ignore answers outside the given range.]

Q23.

- 6 (i) State answer $R = 5$ B1
 Use trig formula to find a M1
 Obtain $a = 53.13^\circ$ A1 [3]
- (ii) Evaluate $\cos^{-1}(4.5/5) \approx 25.84^\circ$ M1
 Obtain answer 79.0° A1
 Carry out correct method for second answer M1
 Obtain answer 27.3° and no others in the given range A1√ [4]
 [Treat the giving of answers in radians as a misread. Ignore answers outside the given range.]

Q24.

- 5 Use correct trig identity to obtain a quadratic in $\cot \theta$ or $\tan \theta$ M1
 Solve the quadratic correctly A1
 Obtain $\tan \theta = \frac{1}{2}$ or $-\frac{2}{3}$ A1√
 Obtain answer 26.6° or 146.3° A1
 Carry out correct method for second answer from either root M1
 Obtain remaining 3 answers from 26.6° , 146.3° , 206.6° , 326.3° and no others in the range A1 [6]
 [Ignore answers outside the given range]

Q25.

- 6 (i) State $R = \sqrt{5}$ B1
 Use trig formula to find α M1
 Obtain $\alpha = 26.57^\circ$ with no errors seen A1 [3]
- (ii) Carry out evaluation of $\sin^{-1}\left(\frac{\pm 0.4}{\sqrt{5}}\right)$ ($\approx \pm 10.3048^\circ$) M1
 Obtain answer 16.3° A1
 Carry out correct method for second answer M1
 Obtain answer 216.9° and no others in the range A1 [4]

Q26.

- 8 (i) State $R = \sqrt{34}$ B1
 Use trig formula to find α M1
 Obtain $\alpha = 30.96^\circ$ with no errors seen A1 [3]
- (ii) Carry out evaluation of $\cos^{-1}\left(\frac{\pm 4}{R}\right)$ ($\approx 46.6861^\circ$ or 313.3139°) M1
 Obtain answer 15.7° A1
 Carry out correct method for second answer M1
 Obtain answer 282.3° or 282.4° and no others in the range A1 [4]
- (iii) State $-3\sqrt{34}$ ($= -3R$) B1√ [1]

Q27.

- 5 Use trig identity correctly to obtain a quadratic in $\tan 2\theta$ M1
 Solve the quadratic correctly M1
 Obtain $\tan 2\theta = 1$ or $-\frac{4}{5}$ A1
 Obtain one correct answer A1
 Carry out correct method for second answer from either root M1
 Obtain remaining 3 answers from 22.5° , 112.5° , 70.7° , 160.7° and no others in the range A1
 [Ignore answers outside the given range] [6]

Q28.

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|---|--|--------------------------|
| 3 | Make relevant use of the $\cos 2\theta$ formula
Obtain a correct quadratic in $\cos \theta$
Solve a quadratic in $\cos \theta$
Obtain answer $\theta = 60$ and no others in the range
(Ignore answers outside the given range) | M1
A1
M1
A1 [4] |
|---|--|--------------------------|

Q29.

- | | | |
|---|--|--------------------------------------|
| 8 | (a) Use $\tan (A + B)$ formula to obtain an equation in $\tan B$
State equation $\frac{t + \tan B}{1 - t \tan B} = 4$, or equivalent
Solve to obtain $\tan B = \frac{4-t}{1+4t}$ | M1
A1
A1 [3] |
| | (b) State equation $2\left(\frac{\tan 45 - \tan x}{1 + \tan 45 \tan x}\right) = 3 \tan x$, or equivalent
Transform to a quadratic equation
Obtain $3 \tan^2 x + 5 \tan x - 2 = 0$ (or equivalent)
Solve the quadratic and calculate one angle, or establish that $\tan x = \frac{1}{3}, -2$
Obtain one answer, e.g. $x = 18.4^\circ$
Obtain other 3 answers $116.6^\circ, 198.4^\circ, 296.6^\circ$ and no others in range | B1
M1
A1
M1
A1
A1 [6] |

Q30.

- | | | |
|---|--|--------------------------------|
| 7 | (i) State $R = \sqrt{10}$
Use trig formula to find α
Obtain $\alpha = 18.43^\circ$ with no errors seen | B1
M1
A1 [3] |
| | (ii) Carry out evaluation of $\cos^{-1}\left(\frac{2}{R}\right) (\approx 50.77^\circ)$
Carry out correct method for one correct answer
Obtain one correct answer e.g. 34.6°
Carry out correct method for a further answer
Obtain remaining 3 answers $163.8^\circ, 214.6^\circ, 343.8^\circ$ and no others in the range | M1
M1
A1
M1
A1 [5] |

Q31.

- | | | |
|---|--|---------------------------------------|
| 3 | Use trig identity correctly to obtain a quadratic in $\operatorname{cosec} \theta$ or $\sin \theta$
Solve the quadratic correctly
Obtain $\sin \theta = \frac{1}{4}$ or $-\frac{3}{5}$
Obtain one correct answer
Carry out correct method for second answer from either root
Obtain remaining 3 answers from 14.5, 165.5, 221.8, 318.2 and no others in the range
[Ignore answers outside the given range] | M1
M1
A1
A1
DM1
A1 [6] |
|---|--|---------------------------------------|

Q32.

- 2 Use $\sin 2\theta = 2 \sin \theta \cos \theta$ B1
 Simplify to obtain form $c_1 \sin^2 \theta = c_2$ or equivalent M1
 Find at least one value of θ from equation of form $\sin \theta = k$ M1
 Obtain 35.3° and 144.7° A1 [4]

Q33.

- 7 (i) Use $\sec^2 \alpha = 1 + \tan^2 \alpha$ B1
 Confirm $3 \tan^2 \alpha + 4 \tan \alpha - 4 = 0$ B1
 Solve quadratic equation for $\tan \alpha$ M1
 Obtain, finally, $\tan \alpha = \frac{2}{3}$ only A1 [4]
- (ii) State or imply $\tan(\alpha + \beta) = \frac{1}{6}$ B1
 State $\frac{\frac{2}{3} + \tan \beta}{1 - \frac{2}{3} \tan \beta} = \frac{1}{6}$, following their value of $\tan \alpha$ B1√
 Solve equation of form $\frac{a + bt}{c + dt}$ for t M1
 Obtain $\tan \beta = -\frac{9}{20}$ A1
 Conclude with $\cot \beta = -\frac{20}{9}$ or exact equivalent A1 [5]

Q34.

- 7 (i) State or imply $R = 13$ B1
 Use appropriate formula to find α M1
 Obtain 67.38° A1 [3]
- (ii) Attempt to find at least one value of $\cos^{-1} \frac{8}{13}$ or $\cos^{-1} \frac{8}{R}$ M1
 Obtain one correct value of θ (240.6 or 344.6) A1
 Carry out correct method to find second value of θ within the range DM1
 Obtain second correct value (344.6 or 240.6) A1 [4]
- (iii) State or imply $7 + 13 \cos(\frac{1}{2}\phi + 67.38)$ following their answers from part (i) B1^A
 State 20 B1
 Attempt to find ϕ for which $\cos(\frac{1}{2}\phi + 67.38) = 1$ M1
 Obtain 585.2 A1 [4]

P3 (variant1 and 3)

Q1.

- 2 Use correct $\cos 2A$ formula and obtain an equation in $\sin \theta$ M1
 Obtain $4 \sin^2 \theta + \sin \theta - 3 = 0$, or equivalent A1
 Make reasonable attempt to solve a 3-term quadratic in $\sin \theta$ M1
 Obtain answer 48.6° A1
 Obtain answer 131.4° and no others in the given range A1 ✓
 Obtain answer 270° and no others in the given range A1 [6]
 [Treat the giving of answers in radians as a misread. Ignore answers outside the given range.]

Q2.

- 3 Attempt to use $\tan(A \pm B)$ formula and obtain an equation in $\tan x$ M1
 Obtain 3-term quadratic $2 \tan^2 x + 3 \tan x - 1 = 0$, or equivalent A1
 Solve a 3-term quadratic and find a numerical value of x M1
 Obtain answer 15.7° A1
 Obtain answer 119.3° and no others in the given interval A1 [5]
 [Ignore answers outside the given interval. Treat answers in radians, 0.274 and 2.08, as a misread.]

Q3.

- 9 (i) Express $\cos 4\theta$ as $2 \cos^2 2\theta - 1$ or $\cos^2 2\theta - \sin^2 2\theta$ or $1 - 2 \sin^2 2\theta$ B1
 Express $\cos 4\theta$ in terms of $\cos \theta$ M1
 Obtain $8 \cos^4 \theta - 8 \cos^2 \theta + 1$ A1
 Use $\cos 2\theta = 2 \cos^2 \theta - 1$ to obtain given answer $8 \cos^4 \theta - 3$ AG A1 [4]
- (ii) (a) State or imply $\cos^4 \theta = \frac{1}{2}$ B1
 Obtain 0.572 B1
 Obtain -0.572 B1 [3]
- (b) Integrate and obtain form $k_1 \theta + k_2 \sin 4\theta + k_3 \sin 2\theta$ M1
 Obtain $\frac{3}{8} \theta + \frac{1}{32} \sin 4\theta + \frac{1}{4} \sin 2\theta$ A1
 Obtain $\frac{3}{32} \pi + \frac{1}{4}$ following completely correct work A1 [3]

Q4.

- 4 (i) Use $\tan(A \pm B)$ formula correctly at least once and obtain an equation in $\tan \theta$ M1
 Obtain a correct horizontal equation in any form A1
 Use $\tan 60^\circ = \sqrt{3}$ throughout M1
 Obtain the given equation correctly A1 [4]
- (ii) Set $k = 3\sqrt{3}$ and obtain $\tan^2 \theta = \frac{1}{11}$ B1
 Obtain answer 16.8° B1 ✓
 Obtain answer 163.2° B1 ✓ [3]
 [Ignore answers outside the given interval. Treat answers in radians (0.293 and 2.85) as a misread.]

Q5.

- 6 (i) Use $\tan(A + B)$ and $\tan 2A$ formulae to obtain an equation in $\tan x$ M1
 Obtain a correct equation in $\tan x$ in any form A1
 Obtain an expression of the form $a \tan^2 x = b$ M1
 Obtain the given answer A1 [4]
- (ii) Substitute $k = 4$ in the given expression and solve for x M1
 Obtain answer, e.g. $x = 16.8^\circ$ A1
 Obtain second answer, e.g. $x = 163.2^\circ$, and no others in the given interval A1 [3]
 [Ignore answers outside the given interval. Treat answers in radians as a misread and deduct A1 from the marks for the angles.]
- (iii) Substitute $k = 2$, show $\tan^2 x < 0$ and justify given statement correctly B1 [1]

Q6.

- 9 (i) State or imply $R = 5$ B1
 Use relevant trigonometry to find α M1
 Obtain $\alpha = 0.6435$ A1 [3]
- (ii) (a) Carry out appropriate method to find one value in given range M1
 Obtain 1.80 A1
 Carry out appropriate method to find second value in given range M1
 Obtain 5.77 and no other value A1 [4]
- (b) Express integrand as $k \sec^2(\theta - \text{their } \alpha)$ for any constant k M1
 Integrate to obtain result $k \tan(\theta - \text{their } \alpha)$ A1
 Obtain correct answer $2 \tan(\theta - 0.6435)$ A1 [3]

Q7.

- 3 Use correct $\tan 2A$ formula and $\cot x = 1/\tan x$ to form an equation in $\tan x$ M1
 Obtain a correct horizontal equation in any form A1
 Solve an equation in $\tan^2 x$ for x M1
 Obtain answer, e.g. 40.2° A1
 Obtain second answer, e.g. 139.8° , and no other in the given interval A1[^] [5]
 [Ignore answers outside the given interval.]
 [Treat answers in radians as a misread and deduct A1 from the marks for the angles.]
 [SR: For the answer $x = 90^\circ$ give B1 and A1 for one of the other angles.]

Q8.

- 3 Attempt use of $\cos(A + B)$ formula to obtain an equation in $\cos \theta$ and $\sin \theta$ M1
 Use trig formula to obtain an equation in $\tan \theta$ (or $\cos \theta$, $\sin \theta$ or $\cot \theta$) M1
 Obtain $\tan \theta = 1/(4 + \sqrt{3})$ or equivalent (or find $\cos \theta$, $\sin \theta$ or $\cot \theta$) A1
 Obtain answer $\theta = 9.9^\circ$ A1
 Obtain $\theta = 189.9^\circ$, and no others in the given interval A1 [5]
 [Ignore answers outside the given interval. Treat answers in radians as a misread (0.173, 3.31).]

[The other solution methods are *via* $\cos \theta = \pm(4 + \sqrt{3}) / \sqrt{(1 + (4 + \sqrt{3})^2)}$ or
 $\sin \theta = \pm 1 / \sqrt{(1 + (4 + \sqrt{3})^2)}$.]

Q9.

- 8 (i) Obtain or imply $R = 4$ B1
 Use appropriate trigonometry to find α M1
 Obtain $\alpha = 52.24$ or better from correct work A1 [3]
- (ii) (a) State or imply $\theta - \alpha = \cos^{-1}(-4 \div R)$ M1
 Obtain 232.2 or better A1 [2]
- (b) Attempt at least one value using $\cos^{-1}(3 \div R)$ M1
 Obtain one correct value e.g. $\pm 41.41^\circ$ A1
 Use $\frac{1}{2}\theta - \alpha = \cos^{-1}\left(\frac{3}{R}\right)$ to find θ M1
 Obtain 21.7 A1 [4]

Q10.

- 6 (i) State or imply $R = \sqrt{10}$ B1
 Use trig formulae to find α M1
 Obtain $\alpha = 71.57^\circ$ with no errors seen A1 [3]
 [Do not allow radians in this part. If the only trig error is a sign error in $\cos(x - \alpha)$ give M1A0]
- (ii) Evaluate $\cos^{-1}(2/\sqrt{10})$ correctly to at least 1 d.p. ($50.7684\dots^\circ$) (Allow 50.7° here) B1√
 Carry out an appropriate method to find a value of 2θ in $0^\circ < 2\theta < 180^\circ$ M1
 Obtain an answer for θ in the given range, e.g. $\theta = 61.2^\circ$ A1
 Use an appropriate method to find another value of 2θ in the above range M1
 Obtain second angle, e.g. $\theta = 10.4^\circ$, and no others in the given range A1 [5]
 [Ignore answers outside the given range.]
 [Treat answers in radians as a misread and deduct A1 from the answers for the angles.]
 [SR: The use of correct trig formulae to obtain a 3-term quadratic in $\tan \theta$, $\sin 2\theta$, $\cos 2\theta$, or $\tan 2\theta$ earns M1; then A1 for a correct quadratic, M1 for obtaining a value of θ in the given range, and A1 + A1 for the two correct answers (candidates who square must reject the spurious roots to get the final A1).]

Q11.

3	(i) State or imply $R = 17$	B1	[3]
	Use correct trigonometric formula to find α	M1	
	Obtain 61.93° with no errors seen	A1	
	(ii) Evaluate $\cos^{-1} \frac{12}{R}$ ($= 45.099$)	M1	
	Obtain answer 107.0°	A1	
	Carry out correct method for second answer	M1	
	Obtain answer 16.8° and no others between 0° and 360°	A1	[4]

Q12.

3	Attempt use of $\sin(A + B)$ and $\cos(A - B)$ formulate to obtain an equation in $\cos \theta$ and $\sin \theta$	M1	
	Obtain a correct equation in any form	A1	
	Use trig. formula to obtain an equation in $\tan \theta$ (or $\cos \theta$, $\sin \theta$ or $\cot \theta$)	M1	
	Obtain $\tan \theta =$, or equivalent (or find $\cos \theta$, $\sin \theta$ or $\cot \theta$)	A1	
	Obtain answer $\theta = 105.9^\circ$, and no others in the given interval [Ignore answers outside the given material]	A1	[5]

Q13.

2	(i) State or imply $R = 25$	B1	
	Use correct trigonometric formula to find α	M1	
	Obtain 16.26° with no errors seen	A1	[3]
	(ii) Evaluate of $\sin^{-1} \frac{17}{R}$ ($= 42.84\dots^\circ$)	M1	
	Obtain answer 59.1°	A1	[2]

Q14.

- 7 (i) Use $\sec\theta = \frac{1}{\cos\theta}$ and $\operatorname{cosec}\theta = \frac{1}{\sin\theta}$ B1
 Use $\sin 2\theta = 2\sin\theta\cos\theta$ and to form a horizontal equation in $\sin\theta$ and $\cos\theta$ or
 fractions with common denominators M1
 Obtain given equation $2\sin\theta + 4\cos\theta = 3$ correctly A1 [3]
- (ii) State or imply $R = \sqrt{20}$ or 4.47 or equivalent B1
 Use correct trigonometry to find α M1
 Obtain 63.43 or 63.44 with no errors seen A1 [3]
- (iii) Carry out a correct method to find one value in given range M1
 Obtain 74.4° (or 338.7°) A1
 Carry out a correct method to find second value in given range M1
 Obtain 338.7° (or 74.4°) and no others between 0° and 360° A1 [4]

Q15.

- 1 (i) State $\sin 2\alpha = 2\sin\alpha\cos\alpha$ and $\sec\alpha = 1/\cos\alpha$ B1
 Obtain $2\sin\alpha$ B1 [2]
- (ii) Use $\cos 2\beta = 2\cos^2\beta - 1$ or equivalent to produce correct equation in $\cos\beta$ B1
 Solve three-term quadratic equation for $\cos\beta$ M1
 Obtain $\cos\beta = \frac{1}{3}$ only A1 [3]

Q16.

- 3 (i) Use $\tan(A \pm B)$ formula and obtain an equation in $\tan x$ M1
 Using $\tan 60^\circ = \sqrt{3}$, obtain a horizontal equation in $\tan x$ in any correct form A1
 Reduce the equation to the given form A1 3
- (ii) Solve the given quadratic for $\tan x$ M1
 Obtain a correct answer, e.g. $x = 21.6^\circ$ A1
 Obtain a second answer, e.g. $x = 128.4^\circ$, and no others A1 3
 [Ignore answers outside the given interval. Treat answers in radians as a misread
 (0.377, 2.24).]

Q17.

- 8 (i) Use $\sin(A + B)$ formula to express $\sin 3\theta$ in terms of trig. functions of 2θ and θ M1
 Use correct double angle formulae and Pythagoras to express $\sin 3\theta$ in terms of $\sin \theta$ M1
 Obtain a correct expression in terms of $\sin \theta$ in any form A1
 Obtain the given identity A1 [4]
 [SR: Give M1 for using correct formulae to express RHS in terms of $\sin \theta$ and $\cos 2\theta$, then M1A1 for expressing in terms of $\sin \theta$ and $\sin 3\theta$ only, or in terms of $\cos \theta$, $\sin \theta$, $\cos 2\theta$ and $\sin 2\theta$, then A1 for obtaining the given identity.]

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- (ii) Substitute for x and obtain the given answer B1 [1]
- (iii) Carry out a correct method to find a value of x M1
 Obtain answers 0.322, 0.799, -1.12 A1 + A1 + A1 [4]
 [Solutions with more than 3 answers can only earn a maximum of A1 + A1.]

Q18.

- 4 (i) Either Use $\cos(A \pm B)$ correctly at least once M1
 State correct complete expansion A1
 Confirm given answer $\cos \theta$ with explicit use of $\cos 60^\circ = \frac{1}{2}$ A1
 SR: “correct” answer from sign errors in both expansions is B1 only
- Or Use correct $\cos A + \cos B$ formula M1
 State correct result e.g. $2 \cos\left(\frac{2\theta}{2}\right) \cos\left(\frac{-120}{2}\right)$ A1
 Confirm given answer $\cos \theta$ with explicit use of $\cos(\pm 60^\circ) = \frac{1}{2}$ A1 [3]
- (ii) State or imply $\frac{\cos 2x}{\cos x} = 3$ B1
 Obtain equation $2 \cos^2 x - 3 \cos x - 1 = 0$ B1
 Solve a three-term quadratic equation for $\cos x$ M1
 Obtain $\frac{1}{4}(3 - \sqrt{17})$ or exact equivalent and, finally, no other A1 [4]

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