Question			Answer	Marks	Guidance
1			$2\sec^2\theta = 5\tan\theta$ $\Rightarrow\ 2(1+\tan^2\theta) = 5\tan\theta$ $\Rightarrow\ 2\tan^2\theta - 5\tan\theta + 2 = 0$ $\Rightarrow\ (2\tan\theta - 1)(\tan\theta - 2) = 0$ $\Rightarrow\ \tan\theta = ½$ or 2 $\Rightarrow\ \theta = 0.464$, 1.107	 M1 A1 M1 A1 A1 A1	 $\sec^2\theta = 1 + \tan^2\theta$ **used** correct quadratic **oe** solving their quadratic for tan θ (follow rules for solving as in Question 1 [*,*] www first correct solution (or better) second correct solution (or better) and no others in the range Ignore solutions outside the range. **SC** A1 for both 0.46 and 1.11 **SC** A1 for both 26.6° and 63.4° (or better) Do not award **SC**s if there are extra solutions in range.
			…………………………………………………………. **OR** $2/\cos^2\theta = 5\sin\theta/\cos\theta$ $\Rightarrow 2\cos\theta = 5\sin\theta\cos^2\theta, \cos\theta \neq 0$ $\Rightarrow \cos\theta(2 - 5\sin\theta\cos\theta) = 0$ $\Rightarrow \cos\theta = 0, or \sin 2\theta = 0.8$ $\Rightarrow \sin 2\theta = 0.8$ $\Rightarrow 2\theta = 0.9273 or 2.2143$ $\Rightarrow \theta = 0.464$, 1.107	 M1 A1 M1 A1 A1 A1 **[6]**	………………………………………………………………………………………… **using** both sec = 1/cos and tan = sin/cos correct one line equation $2 - 5\sin\theta\cos\theta = 0$ or $2\cos\theta = 5\sin\theta\cos^2\theta$ oe (or common denominator). Do not need $\cos\theta \neq 0$ at this stage. **using** $\sin 2\theta = 2\sin\theta\cos\theta$ oe eg $2 = 5\sin\theta\sqrt{(1-\sin^2\theta)}$ and squaring $\sin 2\theta = 0.8$ or, say, $25\sin^4\theta - 25\sin^2\theta + 4 = 0$ first correct solution (or better) second correct solution (or better) and no others in range Ignore solutions outside the range SCs as above

Question			Answer	Marks	Guidance
2			cot 2θ= 3 $\Rightarrow$ tan 2θ = 1/3 $\Rightarrow$ 2θ = 18.43° θ = 9.22° 2θ = 198.43° θ = 99 .22° or (2 tan θ)/(1 – $\tan^2\theta$) = 1/3 $\Rightarrow$ 6 tan θ = 1 – $\tan^2\theta$ $\Rightarrow$ $\tan^2\theta$ + 6tan θ – 1 = 0 $\Rightarrow$ tan θ = –6 ± √(36 /2 = 0. 3 or –6.1623 $\Rightarrow$ θ = 9.22°, 99.22°	 M1 A1 M1 A1 M1 M1 A1 A1 **[4]**	 tan=1 cot **used** soi for first correct solution (9.22 or better eg 9.217) for method for second solution for θ. for second correct solution and no others in range (99.22 or better) or SC ft A1 for 90 +their first solution use of correct double angle formula rearranged to a quadratic = 0 and attempt to solve by formula oe first correct solution second correct solution and no others in the range (9.22, 99.22 or better) or SC ft A1 for 90 + their first solution -1 MR if radians used (0.16, 1.73 or better)

3(i) AC = 5sec α $\Rightarrow$ CF = AC tan β = 5sec α tan β $\Rightarrow$ GF = 2CF = 10sec α tan β *	B1 M1 E1 [3]	oe ACtanβ
(ii) CE = BE – BC = 5 tan($\alpha + \beta$) – 5 tan α = 5(tan($\alpha + \beta$) – tan α) $= 5\left(\frac{\tan\alpha + \tan\beta}{1-\tan\alpha\tan\beta} - \tan\alpha\right)$ $= 5\left(\frac{\tan\alpha + \tan\beta - \tan\alpha + \tan^2\alpha\tan\beta}{1-\tan\alpha\tan\beta}\right)$ $= \frac{5(1+\tan^2\alpha)\tan\beta}{1-\tan\alpha\tan\beta}$ $= \frac{5\tan\beta\sec^2\alpha}{1-\tan\alpha\tan\beta}$ *	 E1 M1 M1 DM1 E1 [5]	 compound angle formula combining fractions $\sec^2 = 1 + \tan^2$
(iii) $\sec^2 45° = 2$, tan 45° = 1 $\Rightarrow$ $CE = \frac{5t \times 2}{1-t} = \frac{10t}{1-t}$ $CD = \frac{10t}{1+t}$ $\Rightarrow$ $DE = \frac{10t}{1-t} + \frac{10t}{1+t} = 10t(\frac{1}{1-t} + \frac{1}{1+t})$ $= 10t\left(\frac{1+t+1-t}{(1-t)(1+t)}\right) = \frac{20t}{1-t^2}$ *	B1 M1 A1 M1 E1 [5]	used substitution for both in CE or CD oe for both adding their CE and CD
(iv) cos 45° = 1/√2 $\Rightarrow$ sec α = √2 $\Rightarrow$ GF = 10√2 tan β = 10√2 t	M1 E1 [2]	
(v) DE = 2GF $\Rightarrow$ $\frac{20t}{1-t^2} = 20\sqrt{2}t$ $\Rightarrow$ $1 - t^2 = 1/\sqrt{2}$ $\Rightarrow$ $t^2 = 1 - 1/\sqrt{2}$ * $\Rightarrow$ $t = 0.541$ $\Rightarrow$ $\beta = 28.4°$	 E1 M1 A1 [3]	 invtan t

4		$\tan 2\theta = \frac{2\tan\theta}{1-\tan^2\theta}$ $\Rightarrow \cot 2\theta = \frac{1}{\tan 2\theta} = \frac{1-\tan^2\theta}{2\tan\theta}$ * $\cot 2\theta = 1 + \tan\theta$ $\Rightarrow \frac{1-\tan^2\theta}{2\tan\theta} = 1+\tan\theta$ $\Rightarrow 1-\tan^2\theta = 2\tan\theta + 2\tan^2\theta$ $\Rightarrow 3\tan^2\theta + 2\tan\theta - 1 = 0$ $\Rightarrow (3\tan\theta - 1)(\tan\theta + 1) = 0$ $\Rightarrow \tan\theta = 1/3,\ \theta = 18.43°, 198.43°$ or $\tan\theta = -1,\ \theta = 135°, 315°$	M1 E1 M1 M1 A3,2,1, 0 **[7]**	oe eg converting either side into a one line fraction(s) involving sin θ and cos θ. quadratic = 0 factorising or solving 18.43°, 198.43°, 135°, 315° –1 extra solutions in th range

5 LHS = $\cot\beta - \cot\alpha$ $= \frac{\cos\beta}{\sin\beta} - \frac{\cos\alpha}{\sin\alpha}$ $= \frac{\sin\alpha\cos\beta - \cos\alpha\sin\beta}{\sin\alpha\sin\beta}$ $= \frac{\sin(\alpha-\beta)}{\sin\alpha\sin\beta}$	M1 M1 E1	cot = cos / sin combining fractions www
OR RHS= $\frac{\sin(\alpha-\beta)}{\sin\alpha\sin\beta} = \frac{\sin\alpha\cos\beta}{\sin\alpha\sin\beta} - \frac{\cos\alpha\sin\beta}{\sin\alpha\sin\beta}$ $=\cot\beta - \cot\alpha$	M1 M1 E1 [3]	using compound angle formula splitting fractions using cot=cos/sin

6	cosec $\theta = 3$ $\Rightarrow \sin\theta = 1/3$ $\Rightarrow \theta = 19.47°$, $160.53°$	M1 A1 A1 [3]	and no others in the range