| | | |
|---|---|---|
| **3(a)** | arc $AB$ arc $CD$ $AC + DB$ $L$<br>Length : $\pi(2a)$ $\pi a$ $2a$ $3\pi a + 2a$<br>(mass) or ratios: $2\pi$ $\pi$ $2$ $3\pi + 2$ | B1 |
| | Distance : $\frac{4a}{\pi}$ $\frac{2a}{\pi}$ $0$ $d$<br>from $AB$ | B1 |
| | $\pi(2a) \times \frac{4a}{\pi} - \pi a \times \frac{2a}{\pi} = (3\pi a + 2a)d$ | M1A1 |
| | $*(d =) \frac{6a}{(3\pi + 2)}$<br>**N.B.** Accept any equivalent form with whole numbers. | A1* |
| | | (5) |
| **3(b)** | tan $OAG$ ( $\alpha$ ) = $\frac{\frac{6a}{(3\pi+2)}}{2a} = \frac{3}{(3\pi+2)}$ | B1 |
| | $\tan\theta = \tan(45^o - \alpha)$ **or** $\tan(\theta + \alpha) = \tan 45^o$ **or** $\tan\alpha = \tan(45^o - \theta)$ | M1 |
| | $\tan\theta = \frac{1-\tan\alpha}{1+\tan\alpha}$ $\frac{\tan\theta + \tan\alpha}{1-\tan\theta\tan\alpha} = 1$ $\tan\alpha = \frac{1-\tan\theta}{1+\tan\theta}$ | **D**M1 |
| | Substitute for $\tan\alpha$ e.g. $\tan\theta = \frac{1-\frac{3}{(3\pi+2)}}{1+\frac{3}{(3\pi+2)}}$ | DM1 |
| | $\tan\theta = \frac{3\pi - 1}{3\pi + 5}$ (must have $\pi$ 's and integers) | A1 |
| | | |
| | **OR** | |
| | | |
| | Let $F$ be on $AE$ where $GF$ is perpendicular to $AE$. | |
| | $GF = GE\sin 45^o$ | B1 |
| | $\tan\theta = \frac{GF}{AF} = \frac{GE\sin 45^o}{AE - GE\cos 45^o}$ | M1 |
| | $= \frac{(2a - \bar{x})\sin 45^o}{2a\sqrt{2} - (2a - \bar{x})\sin 45^o}$ | **D**M1 |
| | $= \frac{(2a - \bar{x})}{(2a + \bar{x})}$ where $\bar{x} = \frac{6a}{(3\pi+2)}$ is substituted in. | DM1 |
| | $= \frac{3\pi - 1}{3\pi + 5}$ | A1 |
| | | (5) |
| | | **(10)** |
| | **Notes for question 3** | |

| | | |
|---|---|---|
| **3(a)** | **N.B.** If they treat it as a lamina, can score max B0B0M1A0A0* | |
| | B1 Mass (length) ratios | |
| | B1 Distances from *AB* or a parallel axis | |
| | M1 Moments about *AB* or parallel axis, dimensionally correct, condone sign errors, using their 'masses' and distances, including all terms. | |
| | A1 Correct unsimplified equation<br>**N.B**. Condone missing brackets on RHS here but penalise the A1* | |
| | A1* Given answer correctly obtained with no errors seen<br>**N.B.** Need to see reference to *AC* and *DB*, either in the table or in the equation**.** | |
| **3(b)** | B1 Correct unsimplified expression for tan *OAG*, seen or implied<br>**N.B.** B0 if they have $OAG = \theta$ | |
| | M1 Correct method seen or implied. May see arctan1 instead of $45^o$<br>**N.B.** If their first line of working is:<br>$\tan\theta = \tan 45^o - \tan\alpha$ oe, treat as a correct method but wrong formula. | |
| | **DM**1 Dependent on previous M for use of a correct formula used to give an equation in $\tan\theta$ and $\tan\alpha$ only | |
| | **DM**1 Dependent on previous M for substitution for **their** $\tan\alpha$ to give an equation in $\tan\theta$ only | |
| | A1 cao. Must be simplified. | |