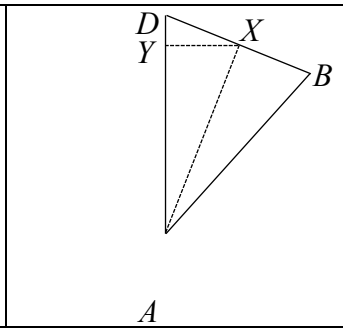
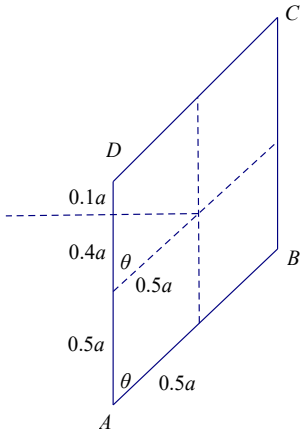
<table>
<tr><th>Question Number</th><th>Scheme</th><th>Marks</th></tr>
<tr><td rowspan="4">4(a)</td><td>Vertical distance from A to C is $a+a\cos\theta$</td><td>B1</td></tr>
<tr><td>“Half the vertical height of the diagram”
Using the symmetry of the figure, the centres of mass of the rhombuses lie on a straight line passing through the centre of mass.</td><td>M1</td></tr>
<tr><td>$0.9a=\frac{1}{2}\left(a+a\cos\theta\right)$</td><td>A1
A1</td></tr>
<tr><td>$\cos\theta=0.8$ *</td><td>A1*</td></tr>
<tr><td></td><td>(5)</td></tr>
<tr><td rowspan="5">Alt1</td><td>Distance from A to centre of rhombus = $a\cos\frac{\theta}{2}$</td><td>B1</td></tr>
<tr><td>“Moments using CoM of two rhombuses”
Taking moments about an axis through A parallel to FB</td><td>M1</td></tr>
<tr><td>$\lambda.a\cos\frac{\theta}{2}.\cos\frac{\theta}{2}+\lambda.a\cos\frac{\theta}{2}\cos\frac{\theta}{2}=2\lambda\times0.9a$</td><td>A1
A1</td></tr>
<tr><td>$\cos\theta=2\cos^2\frac{\theta}{2}-1=0.8$ *</td><td>A1*</td></tr>
<tr><td></td><td>(5)</td></tr>
<tr><td rowspan="5">Alt2</td><td>Distance from A to centre of rhombus (= AX =) $a\cos\frac{\theta}{2}$</td><td>B1</td></tr>
<tr><td>“Vertical height of CoM rhombus”
Using the symmetry of the figure, the centres of mass of the rhombuses lie on a straight line passing through the centre of mass:
$AY=AX\cos\frac{\theta}{2}$

</td><td>M1</td></tr>
<tr><td>$a\cos\frac{\theta}{2}\times\cos\frac{\theta}{2}=0.9a$</td><td>A1
A1</td></tr>
<tr><td>$\cos\theta=2\cos^2\frac{\theta}{2}-1=0.8$ *</td><td>A1*</td></tr>
<tr><td></td><td>(5)</td></tr>
<tr><td rowspan="3">Alt3</td><td><table>
<tr><td>Shape</td><td>EFBC</td><td>EDC</td><td>FAB</td><td>lamina</td></tr>
<tr><td>Mass/Area</td><td>$2a^2\sin\theta$</td><td>$a^2\sin\theta\cos\theta$</td><td>$a^2\sin\theta\cos\theta$</td><td>$2a^2\sin\theta$</td></tr>
<tr><td>CoM</td><td>$a\cos\theta+\frac{a}{2}$</td><td>$a+\frac{2}{3}a\cos\theta$</td><td>$\frac{2}{3}a\cos\theta$</td><td>$0.9a$</td></tr>
</table></td><td>B1</td></tr>
<tr><td>Moments equation (“Rectangle minus triangle plus triangle”)</td><td>M1</td></tr>
</table>

<table>
<tr><td></td><td>$2a^2\sin\theta\left(a\cos\theta+\frac{a}{2}\right)-a^2\sin\theta\cos\theta\left(\frac{2}{3}a\cos\theta+a-\frac{2}{3}a\cos\theta\right)=2a^2\sin\theta\times0.9a$</td><td>A1
A1</td></tr>
<tr><td></td><td>$\cos\theta=0.8$ *</td><td>A1*</td></tr>
<tr><td></td><td></td><td>(5)</td></tr>
<tr><td>Alt4</td><td><table>
<tr><td>Shape</td><td>EDF & BCD</td><td>AFD & ADB</td><td>lamina</td></tr>
<tr><td>Mass/Area</td><td>$2\times\frac{1}{2}a^2\sin\theta$</td><td>$2\times\frac{1}{2}a^2\sin\theta$</td><td>$2a^2\sin\theta$</td></tr>
<tr><td>CoM</td><td>$\frac{2}{3}a(1+\cos\theta)$</td><td>$\frac{1}{3}a(1+\cos\theta)$</td><td>$0.9a$</td></tr>
</table></td><td>B1</td></tr>
<tr><td></td><td>Moments equation (“two upper triangles and two lower triangles”)</td><td>M1</td></tr>
<tr><td></td><td>$2\times\frac{1}{3}a(1+\cos\theta)\times\frac{1}{2}a^2\sin\theta+2\times\frac{2}{3}a(1+\cos\theta)\times\frac{1}{2}a^2\sin\theta=2a^2\sin\theta\times0.9a$</td><td>A1
A1</td></tr>
<tr><td></td><td>$\cos\theta=0.8$ *</td><td>A1*</td></tr>
<tr><td></td><td></td><td>(5)</td></tr>
<tr><td>Alt5</td><td>$AM=a\cos\theta$ (where M is the midpoint of BF)</td><td>B1</td></tr>
<tr><td></td><td>“Midpoint of midpoints”
CoM lies at midpoint of DM</td><td>M1</td></tr>
<tr><td></td><td>$0.9a=a\cos\theta+\frac{1}{2}(a-a\cos\theta)$</td><td>A1
A1</td></tr>
<tr><td></td><td>$\cos\theta=0.8$ *</td><td>A1*</td></tr>
<tr><td></td><td></td><td>(5)</td></tr>
<tr><td>Alt6</td><td>“Working out the heights and trigonometry”

</td><td></td></tr>
<tr><td></td><td>0.4a seen or implied</td><td>B1</td></tr>
<tr><td></td><td>Use of line of centres of rhombuses and trigonometry</td><td>M1</td></tr>
<tr><td></td><td>$\cos\theta=\frac{0.4a}{0.5a}$</td><td>A1
A1</td></tr>
<tr><td></td><td>$\cos\theta=0.8$ *</td><td>A1*</td></tr>
<tr><td></td><td></td><td>(5)</td></tr>
</table>

4(b)	Taking moments about *B*:	M1
	$kW\left(a\cos\theta\right)=W\left(0.9a-a\cos\theta\right)$	A1 A1
	$k=\frac{1}{8}$	A1
		(4)
Alt	Taking moments about *A*:	M1
	$0.9aW=\left(k+1\right)W\times a\cos\theta=\left(k+1\right)\times 0.8aW$	A1 A1
	$k=\frac{1}{8}$	A1
		(4)
		(9 marks)

Notes	
N.B. Be aware that candidates may have worked on a diagram on the question paper and may use their own labelling.	
(a) B1	$a+a\cos\theta$ seen
M1	Use of the symmetry of the figure for the height. Condone sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1*	Obtains given answer from correct exact working.
Alt1 B1	May be marked on a diagram
M1	Taking moments about an axis through *A* parallel to *FB*. Correct number of terms and dimensionally consistent. Condone sin/cos confusion. Any correct ratios in place of λ; may frequently see $a^2\sin\theta$.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation. $\left(\cos^2\frac{\theta}{2}=0.9\right)$
A1*	Obtains given answer from correct exact working.
Alt2 B1	May be marked on a diagram
M1	Use of the symmetry of the figure for the height. Condone sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation. $\left(\cos^2\frac{\theta}{2}=0.9\right)$
A1*	Obtains given answer from correct exact working.
Alt3 B1	Correct division of lamina with correct mass ratios Penalise errors in distance via the moments equation
M1	Moments equation about axis parallel to *FB*. Correct number of terms and dimensionally consistent. Condone sin/cos confusion.

A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1*	Obtains given answer from correct exact working.
Alt4 B1	Correct division of lamina with correct mass ratios Penalise errors in distance via the moments equation
M1	Moments equation about axis parallel to *FB*. Correct number of terms and dimensionally consistent. Condone sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1*	Obtains given answer from correct exact working.
Alt5 B1	May be marked on a diagram
M1	Use of the symmetry of the figure for the height. Condone sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1*	Obtains given answer from correct exact working.
Alt6 B1	May be on a diagram (seen or implied). Could be implied by use of 0.1*a*.
M1	Use of the symmetry of the figure: the CoM lies on a line joining the centres of the rhombuses. Condone sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1*	Obtains given answer from correct exact working.
(b) M1	Moments about *B*. Must have both terms but condone sign errors and sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation. $(0.8kW = 0.1W)$
A1	Cao
Alt M1	Moments about *A* and use of CoM on *FB*. Must have correct number of terms but condone sign errors and sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1	Cao
N.B.	If a candidate does not specify the point about which they are taking moments, do not condone a "mixed approach". E.g. "$kW\left(a\cos\theta\right)=0.9aW$" is M0

Question Number	Scheme	Marks