

Question	Scheme	Marks	AOs
4(a)	Take moments about A	M1	3.3
	$N \times \frac{4a}{\sin \alpha} = Mg \times 3a \cos \alpha$	A1	1.1b
	$\frac{9Mg}{25} *$	A1*	1.1b
		(3)	
4(b)	Resolve horizontally	M1	3.4
	$(\rightarrow) F = \frac{9Mg}{25} \sin \alpha$	A1	1.1b
	Resolve vertically	M1	3.4
	$(\uparrow) R + \frac{9Mg}{25} \cos \alpha = Mg$	A1	1.1b
	Other possible equations: $(\nwarrow), R \cos \alpha + \frac{9Mg}{25} = Mg \cos \alpha + F \sin \alpha$ $(\nearrow), Mg \sin \alpha = F \cos \alpha + R \sin \alpha$ M(C), $Mg \cdot 2a \cos \alpha + F \cdot 5a \sin \alpha = R \cdot 5a \cos \alpha$ M(G), $\frac{9Mg}{25} \cdot 2a + F \cdot 3a \sin \alpha = R \cdot 3a \cos \alpha$ M(B), $Mg \cdot 3a \cos \alpha + F \cdot 6a \sin \alpha = R \cdot 6a \cos \alpha + \frac{9Mg}{25} a$ $(F = \frac{36Mg}{125}, R = \frac{98Mg}{125})$		
	$F = \mu R$ used	M1	3.4
	Eliminate R and F and solve for μ	M1	3.1b
	Alternative equations if they have at A: X horizontally and Y perpendicular to the rod. $(\nwarrow), Y + \frac{9Mg}{25} = Mg \cos \alpha + X \sin \alpha$ $(\nearrow), Mg \sin \alpha = X \cos \alpha$ $(\uparrow), \frac{9Mg}{25} \cos \alpha + Y \cos \alpha = Mg$ $(\rightarrow), Y \sin \alpha + \frac{9Mg}{25} \sin \alpha = X$		

$M(C), Mg.2a \cos \alpha + X.5a \sin \alpha = Y.5a$
 $M(G), \frac{9Mg}{25}.2a + X.3a \sin \alpha = Y.3a$ M1A1 M1A1
 $M(B), Mg.3a \cos \alpha + X.6a \sin \alpha = Y.6a + \frac{9Mg}{25}a$
 $(X = \frac{4Mg}{3}, Y = \frac{98Mg}{75})$
 Then $F = \mu R$ becomes: $X - Y \sin \alpha = \mu Y \cos \alpha$ M1
 Eliminate X and Y and solve for μ M1

$\mu = \frac{18}{49}$ (0.3673.....accept 0.37 or better) A1 2.2a

(7)
(10 marks)

Notes:

4a	M1	<p>Correct no. of terms, dim correct, condone sin/cos confusion and sign errors for an equation in N and Mg only.</p> <p>For perp distance allow any of : $\frac{4a}{\sin \alpha}, \frac{4a}{\cos \alpha}, 5a$ but</p> <p>use of any of : $6a, 5a \sin \alpha, 4a \cos \alpha, \dots$ or anything involving $\tan \alpha$ is M0</p> <p>Also M0 if no a's in their first equation.</p>
	A1	Correct equation, trig does not need to be substituted
	A1*	Given answer correctly obtained.
4b	M1	Correct no. of terms, dim correct, condone sin/cos confusion and sign errors
	A1	Correct equation, trig does not need to be substituted but N does.
	M1	Correct no. of terms, dim correct, condone sin/cos confusion and sign errors
	A1	Correct equation, trig does not need to be substituted but N does.
		<p>N.B. The above 4 marks are for any two equations, either resolutions or moments or one of each. Mark best two equations.</p> <p>Equations may appear in part (a) but must be used in (b) to earn marks.</p>
	M1	<p>Must be used, e.g. seen on the diagram. i.e. M0 if merely quoting it.</p> <p>(M0 if $F = \mu \times \frac{9Mg}{25}$ used)</p>
	M1	Must have 3 equations (<u>and all 3 previous M marks</u>)
	A1	Accept 0.37 or better