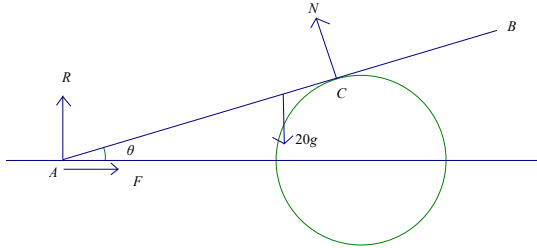


Question	Scheme	Marks	AO
4(a)	Drum smooth , or no friction, (therefore reaction is perpendicular to the ramp)	B1	2.4
		(1)	
(b)	N.B. In (b), for a moments equation, if there is an extra $\sin \theta$ or $\cos \theta$ on a length, give M0 for the equation e.g. $M(A): 20g \times 4 \cos \theta = 5N \sin \theta$ would be given M0A0		
			
	Possible equns	M1	3.3
	(↗): $F \cos \theta + R \sin \theta = 20g \sin \theta$	A1	1.1b
	(↖): $N + R \cos \theta = 20g \cos \theta + F \sin \theta$	M1	3.4
	(↑): $R + N \cos \theta = 20g$	A1	1.1b
	(→): $F = N \sin \theta$	M1	3.4
	$M(A): 20g \times 4 \cos \theta = 5N$	A1	1.1b
	$M(B): 3N + R \times 8 \cos \theta = F \times 8 \sin \theta + 20g \times 4 \cos \theta$		
	$M(C): R \times 5 \cos \theta = F \times 5 \sin \theta + 20g \times \cos \theta$		
	$M(G): R \times 4 \cos \theta = F \times 4 \sin \theta + N$		
	(The values of the 3 unknowns are: $N = 150.528; F = 42.14784; R = 51.49312$)		
	Alternative 1: using cpts along ramp (X) and perp to ramp(Y) Possible equations:	M1	3.3
	(↗): $X = 20g \sin \theta$	A1	1.1b
	(↖): $Y + N = 20g \cos \theta$	M1	3.4
	(↑): $X \sin \theta + Y \cos \theta + N \cos \theta = 20g$	A1	1.1b
	(→): $X \cos \theta = Y \sin \theta + N \sin \theta$	M1	3.4
	$M(A): 20g \times 4 \cos \theta = 5N$	A1	1.1b
	$M(B): 20g \times 4 \cos \theta = 8Y + 3N$		
	$M(C): 20g \times \cos \theta = 5Y$		
	$M(G): 4Y = N \times 1$		
	(The values of the 3 unknowns are: $N = 150.528; X = 54.88; Y = 37.632$)		

Alternative 2: using horizontal cpt (H) and cpt perp to ramp (S)

$$(\nearrow): H \cos \theta = 20g \sin \theta$$

$$(\nwarrow): S + N = H \sin \theta + 20g \cos \theta$$

$$(\uparrow): S \cos \theta + N \cos \theta = 20g$$

$$(\rightarrow): H = S \sin \theta + N \sin \theta$$

$$M(A): 20g \times 4 \cos \theta = 5N$$

$$M(B): 20g \times 4 \cos \theta + H \times 8 \sin \theta = 8S + 3N$$

$$M(C): 20g \times \cos \theta + H \times 5 \sin \theta = 5S$$

$$M(G): 4S = N \times 1 + H \times 4 \sin \theta$$

(The values of the 3 unknowns are:

$$N = 150.528; H = 57.1666...; S = 53.638666...)$$

Solve their 3 equations for F and R **OR** X and Y **OR** H and S

$$|\text{Force}| = \sqrt{R^2 + F^2}$$

Main scheme

$$\text{OR} = \sqrt{X^2 + Y^2}$$

Alternative 1

$$\text{OR} = \sqrt{(H^2 + S^2 - 2HS \cos(90^\circ - \theta))}$$

Alternative 2

Magnitude = 67 or 66.5 (N)

(9)

(c)

Magnitude of the normal reaction (at C) will **decrease**.

(1)

(11)

Marks		Notes
4a	B1	Ignore any extra incorrect comments.
		<p>Generally 3 independent equations required so at least one moments equation.: M1A1M1A1M1A1.</p> <p>More than 3 equations, give marks for the best 3. For each:</p> <p>M1 All terms required. Must be dimensionally correct so if a length is missing from a moments equation it's M0 Condone sin/cos confusion.</p> <p>A1 For a correct equation (trig ratios do not need to be substituted and allow e.g. cos(24/25) if they recover</p> <p><u>Enter marks on ePEN in order in which equations appear.</u></p> <p>N.B. If reaction at <i>C</i> is not perpendicular to the ramp, can only score marks for M(C)</p> <p>Allow use of (μR) for F</p>
4b	M1	All terms required. Must be dimensionally correct. Condone sin/cos confusion.
	A1	Correct unsimplified equation
	M1	All terms required. Must be dimensionally correct. Condone sin/cos confusion.
	A1	Correct unsimplified equation
	M1	All terms required, dim correct, condone sin/cos confusion
	A1	Correct unsimplified equation
		N.B. They can find F and R using only TWO equations, the 1st and 7th in the list. Mark the better equation as M2A2 (-1 each error). Mark the second equation as M1A1
Alt 1	M1	All terms required. Must be dimensionally correct. Condone sin/cos confusion.
	A1	Correct unsimplified equation
	M1	All terms required. Must be dimensionally correct. Condone sin/cos confusion.
	A1	Correct unsimplified equation
	M1	All terms required. Must be dimensionally correct. Condone sin/cos confusion.
	A1	Correct unsimplified equation
		N.B. They can find X and Y using only TWO equations, the 1 st and 7 th in the list. Mark the better equation as M2A2 (-1 each error). Mark the second equation as M1A1
Alt 2	M1	All terms required. Must be dimensionally correct. Condone sin/cos confusion.
	A1	Correct unsimplified equation
	M1	All terms required. Must be dimensionally correct. Condone sin/cos confusion.

	A1	Correct unsimplified equation
	M1	All terms required. Must be dimensionally correct.
	A1	Correct unsimplified equation
		N.B. They can find H and S using only TWO equations, the 1 st and 7 th in the list. Mark the better equation as M2A2 (-1 each error). Mark the second equation as M1A1
	M1	Substitute for trig and solve for their two cpts. This is an independent mark <u>but must use 3 equations</u> (unless it's the special case when 2 is sufficient)
	M1	Use Pythagoras to find magnitude (this is an <u>independent</u> M mark but must have found a value for F (or X) and a value for R (or Y)) OR a complete method to find magnitude e.g. cosine rule but must have found a value for H and a value for S
	A1	Correct answer only
	B1	Ignore reasons