

Topic X4 Centre of mass (Pre-TT B) [45] MARKSCHEME

1.

(i)	$P \times 1.6 = 10g \cos 60 \times 1.2$ $P = 36.75 \text{ N}$	M1 A1 A1 [3]	Moments about A . Allow 36.8
(ii)	$R + 36.75 \sin 30 = 10g$ $F = 36.75 \cos 30$ $\mu = 31.8/79.6$ $\mu = 0.4(00)$	M1 A1 FT B1 FT M1 A1 [5]	Attempt at resolving vertically or taking moments. May be implied. $R = 79.6(25)$ Expect 31.8. Or second correct equation involving F or R or both. For use of (their) $F = \mu(\text{their})R$ R not = $10g$ or their P from (i). AWRW www. Allow inequality

2.

$A = \int_0^3 (2x + x^2) dx$ $= \left[x^2 + \frac{1}{3}x^3 \right]_0^3 = 18$ $A\bar{x} = \int_0^3 x(2x + x^2) dx$ $= \left[\frac{2}{3}x^3 + \frac{1}{4}x^4 \right]_0^3 = \frac{153}{4} = 38.25$ $\bar{x} = \frac{38.25}{18} = \frac{17}{8} = 2.125$ $A\bar{y} = \int_0^3 \frac{1}{2}(2x + x^2)^2 dx$ $= \int_0^3 (2x^2 + 2x^3 + \frac{1}{2}x^4) dx$ $= \left[\frac{2}{3}x^3 + \frac{1}{2}x^4 + \frac{1}{10}x^5 \right]_0^3 = 82.8$ $\bar{y} = \frac{82.8}{18} = 4.6$	M1 A1 M1 M1 A1 M1 M1 M1 A1 9	<i>Definite integrals may be evaluated by calculator (i.e with no working shown)</i> <i>Integrating and evaluating (dependent on previous M1)</i> or $\int_0^{15} (3 - (\sqrt{y+1} - 1))y dy$ <i>Arranging in integrable form</i> <i>Integrating and evaluating</i> <i>SR If $\frac{1}{2}$ is missing, then MOM1M1A0 can be earned for \bar{y}</i>
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3.

(i)	$\bar{u} = 0.2$ (from vertex) or 0.8 or 0.1 $0.5\bar{d} = 0.2 \times \bar{u} + 0.3 \times 0.65$ $\bar{d} = 0.47$	B1 M1 A1 A1 [4]	com of conical shell AG
(ii)	$s = 0.5$ $T \sin 80^\circ \times 0.5 = 0.47 \times 0.5 \times 9.8$ $T = 4.68 \text{ N}$	B1 M1 A1 A1 [4]	slant height, may be implied 8

4.

(a)

	mass	c of m from O
cylinder	$4\pi a^2 h$	$\frac{h}{2}$
hemisphere	$\frac{2}{3}\pi a^3$	$\frac{3}{8}a$
V	$4\pi a^2 h - \frac{2}{3}\pi a^3$	d

Mass ratios

B1

Correct distances

B1

Moments about a diameter through O

M1

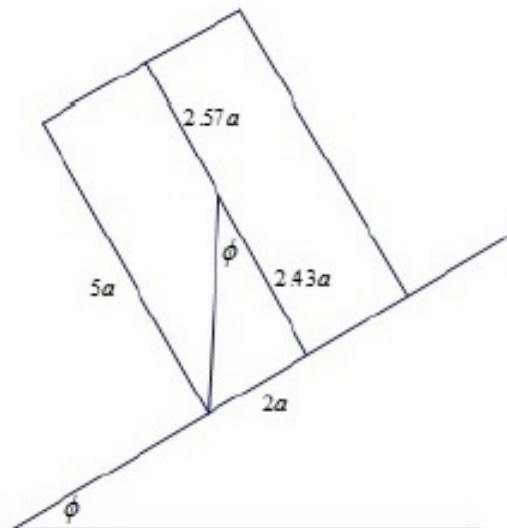
$$4\pi a^2 h \times \frac{h}{2} - \frac{2}{3}\pi a^3 \times \frac{3}{8}a = 2\pi a^2 \left(2h - \frac{1}{3}a\right) \times d$$

A1

$$d = \frac{h^2 - \frac{a^2}{8}}{2h - \frac{a}{3}} = \frac{3(8h^2 - a^2)}{8(6h - a)} \quad *$$

A1*

(b)



$$h = 5a \Rightarrow d = 2.573...a$$

B1

About to topple so c of m above tipping point

M1

$$\Rightarrow \tan \phi = \frac{2a}{5a - 2.573a}$$

A1ft

$$\phi = 39.5^\circ \text{ or } 0.689 \text{ rads}$$

A1

5.

(i)	$50 \times 9.8 \times 2 = R \times 3.75 + 80 \times 9.8 \times 0.25$	M1		moments about D.	
	“	A1		SR/no g/ R = 21.3 (M1A1A0)	
	R = 209 N	A1	3		
(ii)	$130 \bar{x} = 50 \times 2 + 80 \times 4.25$	M1 A1		moments about BC or FE..... $130 \bar{x} = 80 \times 0.25 + 50 \times 2.5$	
	$\bar{x} = 3.385$	A1		$\bar{x} = 1.115$	
	$130 \bar{y} = 50 \times 0.125 + 80 \times 0.25$	M1 A1		moments about EC	
	$\bar{y} = 0.202$	A1			
	$\tan \theta = 0.615 / 0.202$	M1			
	$\theta = 71.8^\circ$ to the horizontal	A1	8	71.6° to 72.0°	11