AQA
Realising potential

TOPIC TEST
MARK SCHEME

A-level
FURTHER MATHS

Centres of Mass 2

Mark scheme v1.0

Specification content coverage: ME5, ME6

Question	Solutions	Mark
1	Resolver vertically $R = W$ Law of friction $F = \mu R = \mu W$ Slides first so $P > F$ hence $P > \mu W$	 1 1
	Total	**2**
2	Position of centre of mass from base of cone $= \frac{h}{4} = \frac{8a}{4} = 2a$ $\tan\theta = \frac{a}{2a} = \frac{1}{2}$ $\theta = 26.6^{o}$	1 1 Use of tan to form ratio 1
	Total	**3**
3	Moments about O where anticlockwise is positive =4(2) – 5(1) +2(2) – 1(3) +3(1) – 2(1) = 5 Nm As this is positive sense is anticlockwise	1 any three pairs correct 1 all six pairings correct 1 magnitude correct 1 signs consistent to deduce anticlockwise
	Total	**4**
4(a)	$4\mathbf{i} + \mathbf{j} + - \mathbf{i} - 2\mathbf{k} + \mathbf{F} = \mathbf{0}$ $\mathbf{F} = -3\mathbf{i} - \mathbf{j} + 2\mathbf{k}$	1
	Total	**1**
4 (b)	$\begin{vmatrix} \mathbf{i} & 1 & 4 \\ \mathbf{j} & 5 & 1 \\ \mathbf{k} & 0 & 0 \end{vmatrix} + \begin{vmatrix} \mathbf{i} & 3 & -1 \\ \mathbf{j} & 0 & 0 \\ \mathbf{k} & -1 & -2 \end{vmatrix} + \begin{vmatrix} \mathbf{i} & 0 & -3 \\ \mathbf{j} & -4 & -1 \\ \mathbf{k} & 2 & 2 \end{vmatrix} = \begin{bmatrix} -6 \\ 1 \\ -31 \end{bmatrix}$ Magnitude = $\sqrt{998}$	1 use of **r** x **F** 1 any 1 component correct 1 all components correct 1 use of Pythagoras to find magnitude
	Total	**4**

5 (a)	Use areas of rectangles as proportional to mass Let $\bar{x}$ be distance of centre of mass from *AB* 0.6(0.75) + 0.3(3) = $0.9\bar{x}$ $\bar{x}$ = 1.5 m $\bar{x}$ = *BC* as required	 1 any area/distance pairing 1 Fully correct equation 1 obtains 1.5 m 1 compares to *BC* or *AD*
	Total	**4**
5(b)	Normal reaction at wall = R Moments about point of contact with floor R(4.5) = 120(3cos 60°) R = $40\sqrt{3}$	 1 LHS 1 RHS 1
	Total	**3**
5(c)	Normal reaction at floor = N Resolve vertically N = 120 Resolve horizontally $F = R = 40\sqrt{3}$ Law of friction $F \le \mu R$ gives $F\mu \ge \frac{F}{R} = \frac{40\sqrt{3}}{120} = \frac{\sqrt{3}}{3}$	 1 1 1
	Total	**3**
6(a)	Use volumes as proportional top masses $\pi r^2(4r)(2r) + \frac{1}{3}\pi r^2\left(4r + \frac{kr}{4}\right) = \left(\pi r^2(4r) + \frac{1}{3}\pi r^2(kr)\right)\bar{x}$ $\bar{x} = \frac{96r + r(16+k)}{48+4k}$ $\bar{x} = \frac{112+k}{48+4k}r$	 1 for cylinder term on LHS 1 for cone term on LHS 1 for RHS 1 equation formed and rearranged 1
	Total	**5**
6(b)	$\tan\theta = \frac{\text{radius}}{\bar{x}} = \frac{48+4k}{112+k}$ $\frac{48+4k}{112+k} = \frac{2}{3}$ k = 8	1 Use of ratio 1 forming equation 1
	Total	**3**
	TOTAL	**32**