

## Topic X4 Centre of mass (Post-TT B) [34] MARKSCHEME

1.

$\text{Volume } V = \int \pi y^2 dx = \int_a^{2a} \pi \frac{a^6}{x^4} dx$ $= \pi \left[ -\frac{a^6}{3x^3} \right]_a^{2a} = \frac{7}{24} \pi a^3$ $V \bar{x} = \int \pi xy^2 dx$ $= \int_a^{2a} \pi \frac{a^6}{x^3} dx$ $= \pi \left[ -\frac{a^6}{2x^2} \right]_a^{2a} = \frac{3}{8} \pi a^4$ $\bar{x} = \frac{\frac{3}{8} \pi a^4}{\frac{7}{24} \pi a^3}$ $= \frac{9a}{7}$	M1  A1  M1  A1  A1  M1  A1 [7]	<i><math>\pi</math> may be omitted throughout</i>  For integrating $x^{-4}$ to obtain $-\frac{1}{3}x^{-3}$  for $\int xy^2 dx$  Correct integral form (including limits)  For integrating $x^{-3}$ to obtain $-\frac{1}{2}x^{-2}$  <i>Dependent on previous M1M1</i>
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2.

(i)	$\cos\theta = 5/13$ or $\sin\theta = 12/13$ or $\theta = 67.4^\circ$  $0.5 \times F \sin\theta = 70 \times 1.4 + 50 \times 2.8$ $F = 516 \text{ N}$	B1 M1 A1 A1 4	any one of these moments about A (ok without 70) $0.5 \sin\theta = 0.4615$ SR 1 for 303 (omission of beam)
ii)	$F \sin\theta = 120 + Y$ (resolving vertically) $Y = 356$ ✓ their $F \times 12/13 - 120$ $X = F \cos\theta$ (resolving horizontally) $X = 198$ ✓ their $F \times 5/13$ Force = $\sqrt{(356^2 + 198^2)}$ 407 or 408 N	M1 A1 ✓ M1 A1 ✓ M1 A1 6	M1/A1 for moments (B) $Y \times 2.8 + 1.4 \times 70 = 2.3 \times 516$ ✓ $\times 12/13$ (C) $0.5 \times Y = 0.9 \times 70 + 2.3 \times 50$ (D) $1.2X = 1.4 \times 70 + 2.8 \times 50$

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3.

direction of R perp. to wall R at $70^\circ$ to rod $0.8 \times 25 \cos 60^\circ = 1.6 \times R \sin 70^\circ$ $0.8 \times 25 \cos 60^\circ$ $1.6 \times R \sin 70^\circ$ $R = 6.65 \text{ N}$	B1 B1 M1 A1 A1 A1 6	$10^\circ$ to horiz. moments about A
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4.

(i)	$\bar{d} = (2 \times 6 \sin \pi/4) / 3\pi/4$ $\bar{d} = 3.60$	M1 A1 2	must be correct formula with rads AG
ii)	$\bar{d} \cos 45^\circ = "2.55"$  $5 \bar{x} = 3 \times 3 + 2 \times "2.55"$  $\bar{x} = 2.82$ $5 \bar{y} = 3 \times 6 + 2 \times (12 + "2.55")$  $\bar{y} = 9.42$	B1  M1 A1 A1 M1 A1 A1 7	may be implied moments must not have areas  2kg/3kg misread (swap) gives (2.73, 11.13) $\theta = 21.7^\circ$ (MR - 2) (max 7 for (ii) + (iii)) SR -1 for $\bar{x}$ , $\bar{y}$ swap
iii)	$\tan\theta = 2.82/8.58$ $\theta = 18.2^\circ$ ✓	M1 A1 2	M0 for their $\bar{x} / \bar{y}$ ✓ their $\bar{x} / (18 - \bar{y})$

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