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	GCE AS/A LEVEL – May/June 2011	9709	51

1	$0 = (15\sin 40^\circ)t - gt^2/2$ $t = 1.93$	M1 A1 [2]	Accept quoting the formula $T = 2V\sin\theta/g$ for the time of flight
2	(i) $x = 2 \times 0.6\sin(\pi/4)/(3\pi/4) [= 0.36(0)]$ $d^2 = 0.6^2 + 0.36^2 - 2 \times 0.6 \times 0.36\cos(\pi/4)$ $d = 0.429$	B1 M1 A1 [3]	Centre of mass from O
	(ii) $\sin\alpha/0.36 = \sin(\pi/4)/0.429$ $\alpha = 36.4^\circ$ or 0.635^c	M1 A1 A1 [3]	
3	(i) EE gain $= 2 \times 24[\sqrt{(0.6^2 + 0.25^2)} - 0.6]/(2 \times 0.6)$ $m \times 0.5^2/2 = 0.1$ $m = 0.8$ (kg) AG	B1 M1 A1 [3]	EE gain = 0.1 KE loss = EE gain
	(ii) $T = 24 \times (0.65 - 0.6)/0.6 (= 2)$ $2 \times 2 \times 0.25/0.65 = 0.8a$ $a = 1.92$	B1 M1 A1 [3]	Newton's Second Law with attempt to resolve 2T
4	(i) $a = 0$ when $x = 2.5$ $v dv/dx = 15 - 6x$ $\int v dv = \int (15 - 6x) dx$ $v^2/2 = [15x - 3x^2] (+ c)$ $v = 6.12$	B1 M1 A1 M1 A1 [5]	For use of limits 0 and 2.5 or evaluating $c(=0)$
	(ii) Solves $15x - 3x^2 = 0$ $a (= 15 - 6 \times 5) = -15\text{ms}^{-2}$	M1 A1 [2]	$x = 5$. Accept assumption $c = 0$.

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5	(i)	$19 \times 0.6/3 + T \times 0.22 = T \times 0.6$ $T = 10$ AG	M1 A1 A1 [3]	Moments about A, 3 terms
	(ii)	$10 = \lambda (0.11 + 0.6 - 0.7)/0.7$ $\lambda = 700$	M1 A1 [2]	
	(iii)	$F^2 = 10^2 + (19 - 10)^2$ $F = 13.5$ $\alpha = \tan^{-1}(9/10) = 42.(0)^\circ$ (with horizontal)	M1 A1 B1 [3]	Or for $a = \tan^{-1}(10/9) = 48^\circ$ (with vertical)
6	(i)	$5 = 0.4(V \sin \alpha) - g \times 0.4^2 / 2$ $V \sin \alpha = 14.5$ $0.4(V \cos \alpha) = 12$ hence $V \cos \alpha = 30$ $V = \sqrt{(30^2 + 14.5^2)}$ $V = 33.3$ $\alpha = 25.8^\circ$	M1 A1 B1 M1 A1 B1 [6]	α is the angle of projection Or $\tan \alpha = 14.5/30$ $\alpha = 25.8^\circ$ $V = 33.3$
	(ii)	$v = 14.5 - 0.4g$ $\tan \theta = (14.5 - 0.4g)/30$ $\theta = \tan^{-1}0.35 = 19.3^\circ$ with the horizontal OR $dy/dx = x \tan \alpha - gx^2 \sec^2 \alpha / (2V^2)$ $\tan \theta = \tan 25.8^\circ - 10 \times 12 \sec^2 25.8^\circ / 33.3^2$ $\theta = 19.3^\circ$ with the horizontal	B1 M1 A1 [3] M1 M1 A1	$v = \sqrt{(14.5^2 - 2g \times 5)}$ $\tan \theta = \sqrt{(14.5^2 - 2g \times 5)} / 30$ For differentiating the trajectory equation For attempting to substitute x , α and v
7	(i)	$0.3 \omega^2 \times 0.5 = T + 0.36 \times 0.3g$ $0.2 \omega^2 \times 0.5 = T - 0.36 \times 0.2g$ $0.1 \omega^2 \times 0.5 = 0.36 \times 0.5g$ $\omega = 6$ $T = 0.3 \times 6^2 \times 0.5 - 0.36 \times 0.3 \times 10$ $T = 4.32$	M1 A1 M1 A1 M1 A1 [6]	Newton's Second Law, 3 terms Both correct
	(ii) (a)	$0.2 \omega^2 r = 0.3 \omega^2 (1 - r)$ $r = 0.6$ $r_P = 0.6$ m and $r_Q = 0.4$ m	M1 A1 A1ft [3]	$0.3 \omega^2 R = 0.2 \omega^2 (1 - R)$ $R = 0.4$
	(ii) (b)	$0.48 = 0.2v_P^2/0.6$ or $0.48 = 0.3v_Q^2/0.4$ $v_P = 1.2$ $v_Q = 0.8$	M1 A1 A1 [3]	Newton's Second Law radially