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	GCE A LEVEL – October/November 2013	9709	51

1	$T = 0.3 \times 5^2 / 0.6$ $T = 12.5 \text{ N}$	M1 A1 [2]	Uses $acc^n = v^2 / r$	[2]
2 (i)	$OG(\text{arc}) = 0.6 \sin(\pi / 2) / (\pi / 2)$ $(0.6 \pi + 2 \times 0.6)d$ $= 2 \times 0.6 \times 0 + 0.6 \pi \times 0.382$ $d = 0.233 \text{ m}$	B1 M1 A1 A1 [4]	0.38197... Moment equation 0.2333..	
(ii)	$\tan \theta = 0.233 / 0.6$ $\theta = 21.2 / 21.3^\circ$ or 0.371 radians	M1 A1ft [2]	$\tan^{-1}(cv(i)/0.6)$	[6]
3 (i)	$0.8v dv/dx = 4e^{-x} - 2.4x^2$ $v dv/dx = 5e^{-x} - 3x^2$ AG	M1 A1 [2]	N2L, terms different signs	
(ii)	$\int v dv = \int (5e^{-x} - 3x^2) dx$ $v^2 / 2 = -5e^{-x} - 3x^3 / 3 (+c)$ $x = 0, v = 6$, hence $c = 23$ $v^2 / 2 = -5e^{-2} - 3x^3 / 3 + 23$ $v = 5.35 \text{ ms}^{-1}$	M1 A1 B1 M1 A1 [5]	Attempts integration Accept c omitted Or uses limits 0 and 2 Puts $x = 2$ in $v(x)$ expression $v = 5.352..$	[7]
4 (i)	$V(\text{vert}) = 14 \sin 60 - 1.8g$ $V^2 = (-)5.8756^2 + (14 \cos 60)^2$ $V = 9.14 \text{ ms}^{-1}$ $\tan \theta = (-)5.8756 / (14 \cos 60)$ $\theta = 40(.0)^\circ$ below horizontal	B1 M1 A1 M1 A1 [5]	-5.8756.. 9.1391..	
(ii)	$-2 = (14 \sin 60)t - gt^2 / 2$ $5t^2 - 12.124t - 2 = 0$ $t = 2.58 \text{ s}$	M1 M1 A1 [3]	$-2 = ut - gt^2 / 2$ used vertically Solves correct 3 term quadratic	[8]

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5 (i) $T_x(4/5) - T_x(3/5) = 0.2g$ $T = 10$ $T_x(4/5) + T_x(3/5) = 0.2v^2 / (0.4 \times 3 / 5)$ $v = 4.1(0) \text{ ms}^{-1}$	M1 A1 A1 M1 A1 [5]	Resolves vertically, 3 forces Maybe implied Resolves horizontally. N2L	
(ii) $T_x(4/5) = 0.2g$ $T_x(3/5) = 0.2 \omega^2 x(0.4 \times 3 / 5)$ $\omega = 5.59 \text{ rads}^{-1}$	B1 M1 A1 [3]	$T = 2.5$ N2L horizontally, single force	[8]
6 (i) $0.8T = 260 \times (DG) \times \cos \theta$ $DG = 1.7/2, \theta = (30+D)$ Angle BDC = 28° $0.8T = 260 \times (1.7/2) \times \cos 58.07$ $T = 146 \text{ N}$ AG	M1 M1 DA1 A1ft A1 [5]	Moments about D Both needed $D = 28.072..$ ftcv($DG \neq 0.8, 1.5, 1.7, \theta \neq 30, 28$)	
OR Moment of weight $= (260 \cos 30) \times 0.75 - (260 \sin 30) \times 0.4$ $0.8T = 116.87..$ $T = 146 \text{ N}$ AG	M1 DA1 M1 A1 A1	Difference of moments of perp components (116.87...) Moments about D Needs no evaluation	
(ii) $F_r = 146 \cos 30$ $R = 260 + 146 \cos 60$ $\mu = (146 \cos 30) / (260 + 146 \sin 30)$ $\mu = 0.38(0)$	B1 B1 M1 A1 [4]	$126.52..$ $333.04..$ Denominator not 260	[9]

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<p>7 (i)</p> $0.4gd = 32(d-0.8)^2 / (2 \times 0.8)$ $20d^2 - 36d + 12.8 = 0$ <p>d = 1.31 m only</p> <p>OR</p> $0.4g(0.8 + e) = 32e^2 / (2 \times 0.8)$ $20e^2 - 4e + 3.2 = 0$ <p>e = 0.5(1) (also -3.12)</p> <p>d = 1.31 m only</p>	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1 [4]</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p>	<p>PE/EE balance</p> <p>Solves 3 term quadratic</p> <p>Other value 0.4876..</p> <p>PE/EE balance</p> <p>Solves 3 term quadratic</p>	
<p>(ii)</p> $0.4v^2 / 2$ $= 0.4g \times 1 - 32(1-0.8)^2 / (2 \times 0.8)$ <p>v = 4 ms⁻¹</p>	<p>M1</p> <p>A1</p> <p>A1 [3]</p>	<p>EE/KE/PE balance</p>	
<p>(iii) Rebound v = 0.8</p> $0 = 0.4 \times 0.8^2 / 2 + 32 \times 0.2^2 / 1.6 - 0.4gh$ <p>OP (=1-h) = 0.768 m</p>	<p>B1ft</p> <p>M1</p> <p>A1 [3]</p>	<p>ftcv(v(ii) × √(1-0.96) = 0.2v(ii)</p> <p>EE/PE/KE balance, h = 0.232</p>	<p>[10]</p>