

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2011	9709	52

1 (i)	$9 \times 0.4 = 0.6 \times T \sin 30$	M1	Moments about A
	$T = 12\text{N}$	A1 [2]	
(ii)	$\mu = (9 - 12 \sin 30) / (12 \cos 30)$	M1	For resolving horizontally and vertically
	$\mu = 0.289$	M1	For using $F = \mu R$
		A1 [3]	
2 (i)	$x = (v \cos 60)0.6$ and	M1	Finds both coordinates in terms of $t = 0.6$
	$y = (v \sin 60)0.6 - g0.6^2/2$	DM1	
	$\tan 45 = [(v \sin 60)0.6 - g0.6^2/2] / [(v \cos 60)0.6]$	A1	
	$v = 8.2(0) \text{ ms}^{-1}$	AG A1 [4]	
(ii)	$8.2 \sin 60 - gt = 8.2 \cos 60$	M1	Relates velocity components and 45°
	$T = 0.3(00) \text{ s}$	A1	
		A1 [3]	
3 (i)	$0.25g = 20e/0.4$	M1	Uses $T = \lambda x/L$
	$OP (= 0.05 + 0.4) = 0.45 \text{ m}$	A1 [2]	
(ii)	$20 \times 0.05^2 / (2 \times 0.4) + 0.25v^2/2$	M1	
	$= 0.25g \times 0.45$	A1	
	$v = 2.92 \text{ ms}^{-1}$	A1 [3]	
(iii)	$20(d - 0.4)^2 / (2 \times 0.4) = 0.25gd$	M1	Hence $d^2 - (0.8 + 0.1)d + 0.16 = 0$
	$d = [0.9 \pm \sqrt{(0.9^2 - 4 \times 0.16)}] / 2$	M1	Solves a 3 term quadratic equation
	$d = 0.656$	A1 [3]	Ignore $d = 0.244$ if seen
4 (i)	$\tan \theta = 0.7 / (2.4/4)$	M1	
	$\theta = 49.4^\circ$	A1 [2]	
(ii)	$h/2 = 2.4/4$	M1	
	$h = 1.2$	A1 [2]	

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2011	9709	52

<p>(iii)</p> $4wVG = w \times 2.4 \times 3/4 + 3w(2.4 + h/2)$ $VG = [\sqrt{(0.7^2 + 2.4^2)}]/\cos\alpha$ $h = 0.944$	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>A1 [5]</p>	<p>Table of values idea, accept $w = 1$</p> <p>Centre of mass above common circumference</p> <p>$\cos\alpha = 2.4/2.5 = 0.96$</p>
<p>5 (i) $0.05dv/dt = 0.05g - 0.01v$</p> $dv/dt = 10 - 0.2v \quad \text{AG}$ $\int dv/(10 - 0.2v) = \int dt$ $-\ln(10 - 0.2v)/0.2 = t (+c)$ <p>$t = 0, v = 0$, hence $c = -5\ln 10$</p> $\ln(10 - 0.2v)/10 = 0.2t, 1 - 0.02v = e^{-0.2t}$ $v = 50 - 50e^{-0.2t}$	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>A1 [6]</p>	<p>Uses Newton's Second Law</p> <p>$-4.60517\dots$</p>
<p>(ii) $dx/dt = 50 - 50e^{-0.2t}$</p> $x = \int (50 - 50e^{-0.2t})dt$ $x = 50t + 50e^{-0.2t}/0.2 (+c)$ $h = [50t + 50e^{-0.2t}/0.2]_2^0$ $h = 17.6$	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1 [4]</p>	<p>Or uses $h = 0, t = 0$ to evaluate $c = (-250)$ and then finds $h(2)$</p>
<p>6 (i) $\theta = \sin^{-1}(0.2/0.7) = 16.6^\circ$ with the vertical</p> $T\cos\theta = 0.3g$ $T + T\sin\theta = 0.3\omega^2 \times 0.2$ $\omega = 8.19$ $\text{KE} (= 0.3 \times (8.19 \times 0.2)^2/2) = 0.402 \text{ J}$	<p>B1</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>A1 [5]</p>	<p>73.4° with the horizontal</p> <p>$T = 3.13$ Resolves vertically</p> <p>Uses Newton's Second Law radially</p> <p>Accept 0.403 J</p>

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – October/November 2011	9709	52

<p>(ii) $(0.9 - AB)/AB = \frac{1}{2}$</p> <p>$AB = 0.6 \text{ m}$</p> <p>$T\cos\alpha - T\sin\alpha = 0.3g$</p> <p>$T = 6.71$</p> <p>$T\cos\alpha + T\sin\alpha = 0.3\omega^2 \times 0.6\sin\alpha$</p> <p>$\omega = 10.6$</p>	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>A1 [6]</p>	<p>$\alpha = \tan^{-1}0.5 = 26.565^\circ$ or $BC/(0.9-BC) = \frac{1}{2}$</p> <p>$BC = 0.3 \text{ m}$</p> <p>Resolves vertically</p> <p>$0.3\omega^2 \times 0.3\cos\alpha$ Uses Newton's Second Law radially</p>
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