



Mathematics

Advanced GCE

Unit 4729: Mechanics 2

Mark Scheme for June 2011

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1	PE = 70x3g	B1	2058
i	KE change = $70x(2.1^2 - 1.4^2)/2$	B1	85.75
	PE change + KE change	M1	Must include evaluation
	2143.75 J	A1	Accept 2140. Allow all values to be negative.
		[4]	
ii		M1	Work done = Energy change used
	20(90 + T) = 2143.75	A1ft	ft(cv(2143.75))
	T = 17.1875 N	A1	accept 17.2
		[3]	
OR		M1	Use of $v^2 = u^2 + 2as$ to find a AND use of N2 law(4 terms)
	70g.0.15 – 90 – T = 70.(-0.06125)	A1	
	T = 17.1875 N	A1	accept 17.2
		[3]	

2	21000/25	B1	Use of force = power/speed
i		M1	3 terms
	0 = 21000/25 – 25k – 1250gsin2	A1	cv(21000/25)
	k = 16.5	A1	
		[4]	
ii		M1	
	21000/v= 16.5v	A1ft	ft on cv(k)
	$v = 35.7 \text{ ms}^{-1}$	A1	
		[3]	

3		M1	Table of moments idea, may include g and/or density.
i	- (8cos30/3)(8 ² sin60/2)	A1	-2.309 x 27.7
	$+(4)(8^2)$	A1	
	$=(8^2+8^2\sin 60/2)(x_G)$	A1	
	$x_{\rm G} = 2.09 \rm cm$	A1	
		[5]	
ii	$\tan\theta = (2.09/4)$	M1	
	$\theta = 27.6^{\circ}$	A1ft	ft cv(x _G)
		[2]	

4	If reversed $2.9 + 2 = e(3 + 1.5)$	M1	
ia	e > 1 impossible	A1	Award B1 if no explicit numerical justification
		[2]	
b	2.9 - 2 = e(3 + 1.5)	MÌ	May be seen in ia
	e = 0.2	A1	
		[2]	
		M1	Conservation of momentum
	3m - 0.2x1.5 = 2m + 0.2x2.9	A1	Accept with a included consistently
	m = 0.88	A1	Do not award if g used
		[3]	
iii	0.68 = 0.2v + 0.2x2.9	M1	Impulse = change in momentum
	v = 0.5	A1	
	e = 0.5/2.9	M1	Separation speed not 2.9
	e = 0.172	A1	Allow 5/29
		[4]	
5	$x = (7\cos 30)t$	B1	
i	$v = (7 \sin 30)t - at^2/2$	B1	
	, (····································	M1	Attempt to eliminate t
	$v = x \tan 30 - \alpha x^2 / (2x7^2 \cos^2 30)$	A1	$v = x/\sqrt{3} - 2x^2/15$ or $v = 0.577x - 0.133x^2$ aef
	,	[4]	,,,,
ii		N1	Create a 3 term Q.E. in x or t with $y = 0.6$
	$2x^{2}/15 - x/\sqrt{3} + 0.6 = 0$ or $9.8t^{2} - 7t + 1.2 = 0$	M1	Solve 3 term Q.E. for x or t
	$x = 1.73 \text{ m or } \sqrt{3} \text{ m}$	A1	
	2.6(0) m or $3\sqrt{3}/2$ m	A1	
		[4]	
iii	$v^2 = (7 \sin 30)^2 - 2x9.8x0.6$	M1	Using $v^2 = u^2$ -2gs with u a component of 7: can find t first
	$v = 0.7 \text{ ms}^{-1}$	A1	from their x in (i), and then use $v = u + at$.
	$\tan\theta = 0.7/(7\cos 30)$	M1	Use component of 7
	$\theta = 6.59^{\circ}$ to horizontal or 83.4° to vertical	A1	
		[4]	
OR	Attempt to differentiate equation of trajectory	M1	
	$\tan 30 - \frac{1}{9} \frac{1}{2} \frac{1}{$	A1	
	Substitute $x = \sqrt{3}$ and equate to tan	M1	Allow $1/\sqrt{3} - 4x/15$ or y' = 0.577 - 0.267x
	$\theta = 6.59^{\circ}$ to horizontal or 83.4° to vertical	A1 [4]	

4729

6		M1	
i	Rsin30 = 0.3g	A1	R = 5.88 or 0.6g
		M1	
	$R\cos 30 = 0.3\omega^2 \times 0.12$	A1	accept $v^2/0.12$ for acceleration
	$\omega = 11.9 \text{ rads}^{-1}$	A1	cao
		[5]	
ii		M1	Resolve and use N2L on sphere Q, 3 terms needed
	$S + Rcos30 = 0.3x2.1^2/0.2$	A1	
	R = 5.88	B1ft	ft cv(R) from (i)
	S = 1.52 N	A1	
		[4]	
iii	$v_{\rm P} = 11.9 \times 0.12$, or h = 0.2/tan30 or 0.12/tan30 or 0.08/tan30	B1	cv(ω) from (i)
	+/-(Q - P) =	M1	Attempt to calculate KE or PE for both particles
	$0.5 \times 0.3 (2.1^2 - (11.9 \times 0.12)^2)$	A2ft	KE difference (ft on $cv(\omega)$) or PE difference
	+ (0.2/tan30 – 0.12/tan30) x 0.3g		
	Q-P = +/- 0.763 J	A1	Q - P = +/-(0.3556 + 0.4074)
		[5]	

7 i	F x 0.8 = 0.6cos60 x 550 F = 206.25	M1 A1 A1 A1	Attempt at moments Accept 206, cao
		[4] M1*	Moment of T about P
"	T x 2 x 0.8/tan30	A1	T x 2.77
	=	M1*	Moment of weight about P
	550 x (0.8/sin30 – 0.6cos60)	A1	550 x (1.6 – 0.3)
	T = 258	A1	Accept to 2sf
		M1*	Resolving vertically, 3 terms needed
	R = 550 – Tcos30	A1	Value for T not required
	Fr = Tsin30	B1*	Value for T not required; accept < or ≤
	μ = 129/326.6	M1dep*	For correct use of F = μ R, R \neq 550
	$\mu = 0.395$	A1	
		[10]	

4729		Mark Schem	June 2011	
OR	T x 0.8/tan30 + 550 x 0.6cos60 = R x 0.8/cos60 R = 550 - Tcos30 Solve for T or R T = 258 or R=326.5625 Fr = Tsin30 μ = 129/326.6 μ = 0.395	M1* A2 M1* A1 M1 A1 B1* M1dep* A1 [10]	Moments about V, 3 terms needed A1 for two terms correct Resolving vertically, 3 terms needed Accept to 2sf Value for T not required; accept < or \leq For correct use of F = μ R, R \neq 550	
OR	Fr x 1.6cos30 + 550 x (1.6sin30 +0.6sin30) = R x (1.6 + 1.6sin30) R = 550 - Tcos30 Fr = Tsin30 Solving for at least one of R, Fr, or T Either R = 326.5625, or Fr = 129(.0017008), or T=258 μ = 129/326.6 μ = 0.395	M1* A2 M1* A1 B1* M1 A1 M1dep* A1 [10]	Moments about Q, 3 terms needed A1 for two terms correct Resolving vertically, 3 terms needed accept < or \leq Only one needed. Accept to 2sf. For correct use of F = μ R, R \neq 550	

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