RECOGNISING ACHIEVEMENT

GCE

Mathematics

Advanced GCE

Unit **4729:** Mechanics 2

Mark Scheme for June 2011

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

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

3 i	 - (8cos30/3)(8^2sin60/2) + (4)(8^2) = (8^2 +8^2sin60/2)(x_G) x_G = 2.09 cm	M1 A1 A1 A1 A1 [5]	Table of moments idea, may include g and/or density. -2.309 x 27.7
ii	tanθ = (2.09/4) θ = 27.6°	M1 A1ft [2]	 ft cv(x_G)

4 ia b	If reversed 2.9 + 2 = e(3 + 1.5) e > 1 impossible 2.9 - 2 = e(3 + 1.5) e = 0.2	M1 A1 [2] M1 A1 [2]	 Award B1 if no explicit numerical justification May be seen in ia
ii	 3m – 0.2x1.5 = 2m + 0.2x2.9 m = 0.88	M1 A1 A1 [3]	Conservation of momentum Accept with g included consistently Do not award if g used
iii	0.68 = 0.2v + 0.2x2.9 v = 0.5 e = 0.5/2.9 e = 0.172	M1 A1 M1 A1 [4]	Impulse = change in momentum Separation speed not 2.9 Allow 5/29

5 i	x = (7cos30)t $y = (7\sin30)t - gt^2/2$ $y = x\tan30 - gx^2/(2x7^2\cos^2 30)$	B1 B1 M1 A1 [4]	 Attempt to eliminate t $y = x/\sqrt{3} - 2x^2/15$ or $y = 0.577x - 0.133x^2$ aef
ii	 $2x^2/15 - x/\sqrt{3} + 0.6 = 0$ or $9.8t^2 - 7t + 1.2 = 0$ x = 1.73 m or $\sqrt{3}$ m 2.6(0) m or $3\sqrt{3}/2$ m	M1 M1 A1 A1 [4]	Create a 3 term Q.E. in x or t with y = 0.6 Solve 3 term Q.E. for x or t
iii **OR**	$v^2 = (7\sin30)^2 - 2x9.8x0.6$ $v = 0.7\ ms^{-1}$ $\tan\theta = 0.7/(7\cos30)$ $\theta = 6.59°$ to horizontal or 83.4° to vertical Attempt to differentiate equation of trajectory $\tan30 - gx/(7^2\cos^2 30)$ Substitute $x = \sqrt{3}$ and equate to $\tan\theta$ $\theta = 6.59°$ to horizontal or 83.4° to vertical	M1 A1 M1 A1 [4] M1 A1 M1 A1 [4]	Using $v^2 = u^2 - 2gs$ with u a component of 7; can find t first from their x in (i), and then use v = u + at. Use component of 7 Allow $1/\sqrt{3} - 4x/15$ or y' = 0.577 – 0.267x

6 i	Rsin30 = 0.3g Rcos30 = $0.3\omega^2$ x 0.12 ω = 11.9 $rads^{-1}$	M1 A1 M1 A1 A1 [5]	 R = 5.88 or 0.6g accept $v^2/0.12$ for acceleration cao
ii	 S + Rcos30 = $0.3x2.1^2/0.2$ R = 5.88 S = 1.52 N	M1 A1 B1ft A1 [4]	Resolve and use N2L on sphere Q, 3 terms needed ft cv(R) from (i)
iii	v_P = 11.9x0.12, or h = 0.2/tan30 or 0.12/tan30 or 0.08/tan30 +/-(Q – P) = $0.5x0.3(2.1^2 – (11.9x0.12)^2)$ + (0.2/tan30 – 0.12/tan30) x 0.3g Q-P = +/- 0.763 J	B1 M1 A2ft A1 [5]	cv(ω) from (i) Attempt to calculate KE or PE for both particles KE difference (ft on cv(ω)) or PE difference Q – P = +/-(0.3556 + 0.4074)

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

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

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