

**Mathematics**

Advanced GCE

Unit **4729**: Mechanics 2

**Mark Scheme for June 2011**

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1	PE = 70x3g KE change = 70x(2.1 <sup>2</sup> – 1.4 <sup>2</sup> )/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	20(90 + T) = 2143.75 T = 17.1875 N	M1 A1ft A1 [3]	Work done = Energy change used ft(cv(2143.75)) accept 17.2
<b>OR</b>	70g.0.15 – 90 – T = 70.(-0.06125) T = 17.1875 N	M1 A1 A1 [3]	Use of v <sup>2</sup> =u <sup>2</sup> + 2as to find a AND use of N2 law(4 terms)  accept 17.2
2	21000/25	B1	Use of force = power/speed
i	0 = 21000/25 – 25k – 1250gsin2 k = 16.5	M1 A1 A1 [4]	3 terms cv(21000/25)
ii	21000/v = 16.5v v = 35.7 ms <sup>-1</sup>	M1 A1ft A1 [3]	ft on cv(k)
3	- (8cos30/3)(8 <sup>2</sup> sin60/2) + (4)(8 <sup>2</sup> ) = (8 <sup>2</sup> + 8 <sup>2</sup> sin60/2)(x <sub>G</sub> ) x <sub>G</sub> = 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 <sub>G</sub> )

4 ia	If reversed $2.9 + 2 = e(3 + 1.5)$ $e > 1$ impossible	M1 A1 [2]	Award B1 if no explicit numerical justification
b	$2.9 - 2 = e(3 + 1.5)$ $e = 0.2$	M1 A1 [2]	May be seen in ia
ii	$3m - 0.2 \times 1.5 = 2m + 0.2 \times 2.9$ $m = 0.88$	M1 A1 A1 [3]	Conservation of momentum Accept with g included consistently Do not award if g used
iii	$0.68 = 0.2v + 0.2 \times 2.9$ $v = 0.5$ $e = 0.5/2.9$ $e = 0.172$	M1 A1 M1 A1 [4]	Impulse = change in momentum  Separation speed not 2.9 Allow 5/29
5 i	$x = (7\cos 30)t$ $y = (7\sin 30)t - gt^2/2$  $y = x \tan 30 - gx^2/(2 \times 7^2 \cos^2 30)$	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	$v^2 = (7\sin 30)^2 - 2 \times 9.8 \times 0.6$ $v = 0.7 \text{ ms}^{-1}$ $\tan \theta = 0.7/(7\cos 30)$ $\theta = 6.59^\circ$ to horizontal or $83.4^\circ$ to vertical	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
OR	Attempt to differentiate equation of trajectory $\tan 30 - gx/(7^2 \cos^2 30)$ Substitute $x = \sqrt{3}$ and equate to $\tan \theta$ $\theta = 6.59^\circ$ to horizontal or $83.4^\circ$ to vertical	M1 A1 M1 A1 [4]	Allow $1/\sqrt{3} - 4x/15$ or $y' = 0.577 - 0.267x$

6 i	$R\sin 30 = 0.3g$  $R\cos 30 = 0.3\omega^2 \times 0.12$ $\omega = 11.9 \text{ rads}^{-1}$	M1 A1 M1 A1 A1 [5]	$R = 5.88$ or $0.6g$  accept $v^2/0.12$ for acceleration cao
ii	$S + R\cos 30 = 0.3 \times 2.1^2 / 0.2$ $R = 5.88$ $S = 1.52 \text{ N}$	M1 A1 B1ft A1 [4]	Resolve and use N2L on sphere Q, 3 terms needed  ft $cv(R)$ from (i)
iii	$v_P = 11.9 \times 0.12$ , or $h = 0.2/\tan 30$ or $0.12/\tan 30$ or $0.08/\tan 30$ $\pm(Q - P) =$ $0.5 \times 0.3(2.1^2 - (11.9 \times 0.12)^2)$ $+ (0.2/\tan 30 - 0.12/\tan 30) \times 0.3g$ $Q - P = \pm 0.763 \text{ J}$	B1 M1 A2ft  A1 [5]	$cv(\omega)$ from (i) Attempt to calculate KE or PE for both particles KE difference (ft on $cv(\omega)$ ) or PE difference  $Q - P = \pm(0.3556 + 0.4074)$
7 i	$F \times 0.8 =$ $0.6\cos 60 \times 550$ $F = 206.25$	M1 A1 A1 A1 [4]	Attempt at moments  Accept 206, cao
ii	$T \times 2 \times 0.8/\tan 30$ $=$ $550 \times (0.8/\sin 30 - 0.6\cos 60)$ $T = 258$  $R = 550 - T\cos 30$ $F_r = T\sin 30$ $\mu = 129/326.6$ $\mu = 0.395$	M1* A1 M1* A1 A1 M1* A1 B1* M1dep* A1 [10]	Moment of T about P $T \times 2.77$ Moment of weight about P $550 \times (1.6 - 0.3)$ Accept to 2sf Resolving vertically, 3 terms needed Value for T not required Value for T not required; accept $<$ or $\leq$ For correct use of $F = \mu R$ , $R \neq 550$

<p><b>OR</b></p>	$T \times 0.8/\tan 30 + 550 \times 0.6\cos 60 = R \times 0.8/\cos 60$ $R = 550 - T\cos 30$ <p>Solve for T or R</p> $T = 258 \text{ or } R = 326.5625$ $Fr = T\sin 30$ $\mu = 129/326.6$ $\mu = 0.395$	<p>M1*</p> <p>A2</p> <p>M1*</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>B1*</p> <p>M1dep*</p> <p>A1</p> <p>[10]</p>	<p>Moments about V, 3 terms needed</p> <p>A1 for two terms correct</p> <p>Resolving vertically, 3 terms needed</p> <p>Accept to 2sf</p> <p>Value for T not required; accept <math>&lt;</math> or <math>\leq</math></p> <p>For correct use of <math>F = \mu R</math>, <math>R \neq 550</math></p>
<p><b>OR</b></p>	$Fr \times 1.6\cos 30 + 550 \times (1.6\sin 30 + 0.6\sin 30) =$ $R \times (1.6 + 1.6\sin 30)$ $R = 550 - T\cos 30$ $Fr = T\sin 30$ <p>Solving for at least one of R, Fr, or T</p> <p>Either <math>R = 326.5625</math>, or <math>Fr = 129(.0017008)</math>, or <math>T = 258</math></p> $\mu = 129/326.6$ $\mu = 0.395$	<p>M1*</p> <p>A2</p> <p>M1*</p> <p>A1</p> <p>B1*</p> <p>M1</p> <p>A1</p> <p>M1dep*</p> <p>A1</p> <p>[10]</p>	<p>Moments about Q, 3 terms needed</p> <p>A1 for two terms correct</p> <p>Resolving vertically, 3 terms needed</p> <p>accept <math>&lt;</math> or <math>\leq</math></p> <p>Only one needed. Accept to 2sf.</p> <p>For correct use of <math>F = \mu R</math>, <math>R \neq 550</math></p>

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