

CAMBRIDGE
INTERNATIONAL EXAMINATIONS

JUNE 2002

**GCE Advanced Level
GCE Advanced Subsidiary Level**

MARK SCHEME

MAXIMUM MARK : 50

SYLLABUS/COMPONENT : 9709 /5, 8719 /5

**MATHEMATICS
(Mechanics 2)**



UNIVERSITY of CAMBRIDGE
Local Examinations Syndicate

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1	(i)	Uses the correct EPE formula $[25 \times 0.4^2 / (2 \times 1.6)]$	M1	
		Obtains 1.25 J	A1	
		Obtains GPE = $0.15g \times 0.4 = 0.6$ J	B1	3
	(ii)	Attempts to form an energy equation involving EPE, GPE and KE terms $[1.25 = \frac{1}{2} 0.15v^2 + 0.6]$	M1	
		Obtains speed as 2.94 ms^{-1} (2.943920)	A1	2

2	(i)	Identifies the distance of centre of mass from vertical face as $(1/3) \times \text{base}$ $[\bar{x} = 10/3]$ Use of $1/3 \times 10$ or $2/3 \times 10$	B1 M1	
		Maximum overhang is 6.67 cm (20/3) ft for $10 - \bar{x}$	B1 A1	2
	(ii)	Identifies the maximum possible width for books as $100 - 2\bar{x}$ and divides by 5 $[100 - 20/3]/5]$	M1	
		Obtains greatest number as 18	A1	2

3		Obtains extension of string as 0.2m (or half-extension as 0.1m)	B1	
		Finds the tension by using the correct Hooke's Law formula ($\text{num. must be 0.1, not 0.8 or 0.4}$)	M1	
		$T = 12 \times 0.2/0.8$ or $T = 12 \times 0.1/0.4$ $[= 3]$	A1	
		Resolves forces on the particle vertically and substitutes for T and $[W = 2 \times 3 \times (0.14/0.5)$ or $2 \times 3 \cos 73.74^\circ]$ with some treatment of $\cos \theta$	M1	
		Obtains $W = 1.68$	A1	5

4	(i)	Use $a = \omega^2 r$ $[16 \times 1.2 \sin 45^\circ]$	M1	
		Obtains acceleration as 13.6 ms^{-2} (13.57645)	A1	2
	(ii)	Uses Newton's 2 nd Law either horizontally or perpendicular to OP to obtain a 3 term equation	M1	
		$T \sin 45^\circ + N \cos 45^\circ = 0.3 \times 13.576$ or $N - 0.3g \sin 45^\circ = 0.3 \times 13.576 \cos 45^\circ$	A1 ft	
		Resolves forces vertically or uses Newton's 2 nd Law along OP to obtain a 3 term equation	M1	
		$N \sin 45^\circ = T \cos 45^\circ + 0.3g$ or $T + 0.3g \cos 45^\circ = 0.3 \times 13.576 \sin 45^\circ$	A1 ft	
		Obtains tension as 0.759 N (0.75868)	A1	
		Obtains force exerted by the cone as 5.00 N (5.00132) (A1 to 5N)	A1	6

SR1 Answers left in surd form, penalise once only.
 SR2 If force exerted by P on cone vertical, allow
 $N = T \cos 45^\circ + 0.3g$ (R1); $T \cos 45^\circ = 0.3 \times 13.576$ (R1) (max 2/6)

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5	(i)	Uses $(A_1 + A_2)\bar{x} = A_1\bar{x}_1 + A_2\bar{x}_2$ [0.09 $\bar{x} = 0.05 \times 0.25 + 0.04 \times 0.45$]	M1	
		$\bar{x} = 0.0305/0.09$ (or $\bar{x} = \frac{2}{180}$ from B) (= 61/180 or 0.3388889)	A1	
		Alternatively for the above 2 marks: Splits the lamina into 2 rectangles of weights 5 N and 4 N or considers it as a square of weight 25 N from which a square of weight 16 N is removed M1 Obtains moment distances as 0.25 and 0.45 or 0.2 and 0.45 (2 rectangles cases) or 0.25 and 0.2 (2 squares case) (distances may be implied) A1		
		Takes moments about A to obtain an equation for T	M1	
		$9 \times 0.0305/0.09 = 0.5T \sin 30^\circ$ or $5 \times 0.25 + 4 \times 0.45 = 0.5T \sin 30^\circ$ or $4 \times 0.2 + 5 \times 0.45 = 0.5T \sin 30^\circ$ or $25 \times 0.25 - 16 \times 0.2 = 0.5T \sin 30^\circ$	A1 ft	
		Obtains tension as 12.2 N (Allow any answer which rounds to 12.2)	A1	5
	(ii)	Obtains vertical component of force at A as 2.9 N (ft for $9 - \frac{1}{2}T$)	B1 ft	
		Obtains horizontal component of force at A as $6.1\sqrt{3}$ N (= 10.5655) (ft for $\frac{1}{2}T\sqrt{3}$)	B1 ft	
		Uses $F^2 = H^2 + V^2$	M1	
		Obtains magnitude as 11.0 N (10.95628) (Allow 11 N)	A1	4

6	(i)	0.4a 0.1v Uses Newton 2 w, H $a = v dv/dx$	B1 M1	
		(With a = v dv/dx) $dv/dx = -1/4$ obtained correctly	B1 A1	
		Integrates and uses $v(0) = 2$ [$v = -x/4 + 2$]	M1	
		Obtains the distance as 8 m	A1	4
	(ii)(a)	Obtains $F = 3/40 \times 0.4g$ [= 0.3]	B1	
		Uses Newton's 2 nd law and $a = dv/dt$ (2 nd term equation with F) [$0.4 dv/dt = -0.1v - F$]	M1	
		Obtains the given equation $4 dv/dt = -(v + 3)$ correctly	A1	3
	(b)	Obtains $t = -4 \ln(v + 3)$ (+C) (a.e.f.)	B1	
		and puts $v=0$ Uses $v(0) = 2$ to find C (or evaluates $\int_2^0 \frac{1}{v} dv$ (M1 awarded only if $t = f(v)$ is a ln function))	M1	
		$t = 4 \ln 5/3$ (= 2.04)	A1	3

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7	(i)	Substitutes $\theta = 30^\circ$, $x = 10$ and $y = 2$ into the correct general equation for the trajectory $\left[2 = 10 \tan 30^\circ - \frac{100g}{2V^2 \cos^2 30^\circ} \right]$ or eliminates T from $10 = \frac{VT \sqrt{3}}{2}$, $2 = \frac{VT}{2} - 5T^2$ (for a correct equation in V) $\left[2 = \frac{10}{\sqrt{3}} - 5 \left(\frac{400}{3V^2} \right) \right]$ eg $2 = 10V \sin 30^\circ \cdot \frac{10}{V \cos 30^\circ} - 5T^2$	M1 B1	
		Transposes to obtain a numerical expression for V^2 (or from $AV^2 = B$; eg $V^2 = \frac{1000}{2(0.75) \left(\frac{10}{\sqrt{3}} - 2 \right)}$ ($= 176.6705$) If $\frac{C}{V^2} = D$ only $V = \sqrt{\frac{C}{D}}$ (FT)	M1	
		Obtains $V = 13.3$ (13.29175)	A1	3
	(ii)	Substitutes for V in $10 = \frac{VT \sqrt{3}}{2}$ or $2 = \frac{VT}{2} - 5T^2$ and solves for T	M1	
		Obtains $T = 0.869$ (0.868735) (If vertical motion is considered, the A mark is awarded only if verification that the value of T found corresponds to (10, 20) rather than (5.3, 2) takes place)	A1	2
	(iii)	Uses $\tan \alpha = \pm \frac{\dot{y}}{\dot{x}}$ or $\tan \alpha = \pm \frac{dy}{dx}$ (Allow $\tan \theta = \dot{x}/\dot{y}$)	M1	
		Obtains $\dot{x} = 13.3 \sqrt{3}/2$ $13.3 \cos 30^\circ$ (or $\frac{10}{0.869}$) [11.511] or $\frac{dy}{dx} = \tan 30^\circ - \frac{gx}{(176.67)(0.75)}$ [0.57735 - 0.07547x]	B1 ft	
		$\dot{y} = 13.3/2 - 10(0.869)$ $13.3 \sin 30^\circ - 10(0.869)$ [-2.041477] or $\frac{dy}{dx} = \tan 30^\circ - \frac{10g}{(176.67)(0.75)}$ [0.57735 - 0.7547]	B1 ft	
		Obtains angle as 169.9° (169.9432) or $(\pm) 0.1^\circ$ (10.0568)	A1	4