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

1	(i)	Uses the correct EPE formula $[25\times0.4^2/(2\times1.6)]$	M1	
		Obtains 1.25 J	A1	
		Obtains GPE = $0.15g\times0.4 = 0.6$ 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)x base~~ $\cancel{[\bar{x} = 10/3]}$ Use of $\frac{1}{3}\times10$ or $\frac{2}{3}\times10$	~~B1~~ M1	
		Maximum overhang is 6.67 cm (20/3) ft for $10 - \bar{x}$	~~B1ft~~ 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 (denom. must be either 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 $[W = 2\times3\times(0.14/0.5)$ or $2 \times 3 \cos 73.74°]$ with some treatment of $\cos\theta$	M1	
		Obtains $W = 1.68$	A1	5

4	(i)	Use $a = \omega^2 r$ $[16 \times 1.2 \sin45°]$	M1	
		Obtains acceleration as 13.6ms^{-2} (13.57645)	A1	2
	(ii)	Uses Newton's 2nd Law either horizontally or perpendicular to OP to obtain a 3 term equation	M1	
		$T\sin45° + N\cos45° = 0.3 \times 13.576$ or $N - 0.3g\sin45° = 0.3 \times 13.576\cos45°$	A1 ft	
		Resolves forces vertically or uses Newton's 2nd Law along OP to obtain a 3 term equation	M1	
		$N\sin45° = T\cos45° + 0.3g$ or $T + 0.3g\cos45° = 0.3 \times 13.576\sin45°$	A1 ft	
		Obtains tension as 0.759 N (0.75868)	A1	
		Obtains force exerted by the cone as 5.00 N (5.00132) (Allow 5N)	A1	6

SR1 Answers left in surd form, penalise once only.
SR2 If force exerted by P on cone vertical, allow
$N = T\cos45° + 0.3g$ (B1); $T\cos45° = 0.3 \times 13.576$ (B1) (max 2/6)

5	(i)	Uses $(A_1 + A_2)\bar{x} = A_1\bar{x}_1 + A_2\bar{x}_2$ [$0.09\bar{x} = 0.05\text{x}0.25 + 0.04\text{x}0.45$]	M1	
		$\bar{x} = 0.0305/0.09$ (or $\bar{x} = \frac{29}{180}$ 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	
		9x0.0305/0/09 = 0.5Tsin 30° or 5 x 0.25 + 4 x 0.45 = 0.5Tsin 30° or 4 x 0.2 + 5 x 0.45 = 0.5Tsin 30° or 25 x 0.25 - 16 x 0.2 = 0.5Tsin 30°	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 – ½ T)	B1 ft	
		Obtains horizontal component of force at A as $6.1\sqrt{3}$ N (= 10.5655) (ft for ½ $T\sqrt{3}$)	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 with $a = v\,dv/dx$	~~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 x 0.4g [=0.3]	B1	
		Uses Newton's 2nd law and $a = dv/dt$ (3 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	
		Uses v (0) = 2 to find C and puts v=0 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

7	(i)	Substitutes $\theta = 30°$, $x = 10$ and $y = 2$ into the correct general equation for the trajectory $[2 = 10\tan 30° - \frac{100g}{2V^2\cos^2 30°}]$ or eliminates T from $10 = \frac{VT\sqrt{3}}{2}$, $2 = \frac{VT}{2} - 5T^2$ (for a correct equation in V. eg $2 = 10V\sin 30° \cdot \frac{10}{V\cos 30°} - $ etc) $[2 = \frac{10}{\sqrt{3}} - 5\left(\frac{400}{3V^2}\right)]$	~~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 seen, give M1 ($V = \sqrt{C/D}$ 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 $\dot{x} = \cancel{13.3\sqrt{3}/2}$ $13.3\cos 30°$ (or $\frac{10}{0.869}$) [11.511] or $\frac{dy}{dx} = \tan 30° - \frac{gx}{(176.67)(0.75)}$ [$0.57735 - 0.07547x$]	B1 ft	
		$\dot{y} = \cancel{13.3/2 - 10(0.869)}$ $13.3\sin 30° - 10(0.869)$ [-2.041477] or $\frac{dy}{dx} = \tan 30° - \frac{10g}{(176.67)(0.75)}$ [$0.57735 - 0.7547$]	B1 ft	
		Obtains angle ~~as 169.9°~~ (1~~69.9432~~) or (±)10.1° (10.0568)	A1	4