CAMBRIDGE
INTERNATIONAL EXAMINATIONS

November 2003

GCE A AND AS LEVEL

MARK SCHEME
MAXIMUM MARK: 50
SYLLABUS/COMPONENT: 9709/05, 8719/05 MATHEMATICS AND HIGHER MATHEMATICS Paper 5 (Mechanics 2)

1		For using Newton's second law with $a = v^2/r$	M1
		$F = 50\,000\ \dfrac{25^2}{1250}$	A1
		Magnitude of the force is 25 000 N	A1
			[3]
2	(i)	For stating or implying that the centre of mass is vertically above the lowest point of the cone, and with $\overline{y} = 5$	B1
		For using $\tan\theta = \dfrac{10}{\overline{y}}$ or equivalent	M1
		$\theta = 63.4°$	A1
			[3]
	(ii)	For using $F < \mu R$	M1
		$mg\sin\theta < \mu mg\cos\theta$	A1

Alternative for the above 2 marks:

For using $\mu = \tan\phi$ where ϕ is the angle of friction	M1
$\phi > \theta$ because cone topples without sliding	A1

		Coefficient is greater than 2 (ft on $\tan\theta$ in (i))	A1ft

N.B. Direct quotation of "topples if $\mu > \tan\theta$" (scores B2); $\mu > 2$ (B1)

[3]

3	(i)	$T = \dfrac{88 \times 0.1}{0.4}$	B1
		For using Newton's second law ($22 - 0.2 \times 10 = 0.2a$) (3 term equation needed)	M1
		Initial acceleration is 100 ms^{-2}	A1
			[3]
	(ii)	For using EPE = $\dfrac{\lambda x^2}{2L}$ $\quad\left(\dfrac{88 \times 0.1^2}{2 \times 0.4}\right)$	M1
		Initial elastic energy is 1.1 J	A1
			[2]
	(iii)	Change in GPE = 0.2 x 10 x 0.1	B1
		For using the principle of conservation of energy (KE, EPE and GPE must all be represented)	M1
		$[\frac{1}{2}0.2v^2 = 1.1 - 0.2]$	
		Speed is 3 ms^{-1}	A1
			[3]

4	(i)	e.g. For taking moments about *BC*	M1
		Distance of centre of mass of triangular portion is $9.5 + \frac{1}{3} \text{ x } 6 \quad (= 11.5)$	B1
		$8 \times 9.5 \times 4.75 + \frac{1}{2} \times 8 \times 6 \times 11.5 = (8 \times 9.5 + \frac{1}{2} \times 8 \times 6)\,\bar{x}$	A1ft
		Distance is 6.37 cm	A1
N.B.		Alternative method	
		e.g. Moments about axis through *A* perpendicular to *AB*	M1
		Distance of C.O.M. of triangular piece removed is 2	B1
		$(8 \times 15.5) \times 7.75 - (\frac{1}{2} \times 8 \times 6) \times 2 = (124 - 20)\,\bar{x}_1$	A1ft
		($\bar{x}_1 = 9.13$) therefore distance is 6.37 cm	A1
			[4]
	(ii)	For taking moments about *A*	M1
		For LHS of $80(15.5 - 6.37) = T \times 15.5 \sin 30°$	A1ft
		For RHS of above equation	A1
		Tension is 94.2 N	A1
			[4]
	(iii)	For resolving forces on the lamina vertically (3 term equation) ($V = 80 - 94.2 \times 0.5$) or taking moments about *B* ($15.5V = 8 \times 10 \times 6.37$)	M1
		Magnitude of vertical component is 32.9 N	A1ft
			[2]

5	(i)	For using $\dot{y} = \dot{y}_0 - gt$ with $\dot{y} = 0$ $(t = 2\sin\alpha)$	M1
		For using y = $\dot{y}_0 t - \frac{1}{2}gt^2$ with t as found and $y = 7.2$, or show $t = 1.2$ as in (ii)	M1
		Alternatively for using $y_{max} = \frac{V^2\sin^2\alpha}{2g}$ with $y_{max} = 7.2$ and $V = 20$ or $\dot{y}^2 = \dot{y}_0^2 - 2gy$ with $\dot{y} = 0$	M2
		$7.2 = \frac{400\sin^2\alpha}{20}$	A1
		Angle is 36.9°	A1
			[4]
	(ii)	Speed on hitting the wall is 20 × 0.8 (use of ball rebounding at 10 ms^{-1} scores B0)	B1ft
		For using $y = 0 - \frac{1}{2}gt^2$ $(-7.2 = -\frac{1}{2}10t^2)$ or $0 = \dot{y} - gt$ $(0 = 12 - 10t)$	M1
		$t = 1.2$	A1
		Distance is 9.6 m (No ft if rebound velocity = 10 ms^{-1})	A1ft
		Alternative – speed on hitting the wall is 20 × 0.8	B1ft
		Use trajectory equation, with $\theta = 0°$	M1
		$-7.2 = x\tan 0° - \frac{gx^2}{2.8^2\cos^2 0°}$ (allow ft with halving attempt including 10)	A1ft
		$x = 9.6$ m	A1
			[4]
	(iii)	$\dot{y} = \mp 10 \times 1.2$	B1ft
		$\theta = \tan^{-1}(\mp)\frac{\dot{y}}{\dot{x}}$ ($\dot{x}$ must have halving attempt. Allow $\dot{x} = 10$)	M1
		Required angle is 56.3°	A1
			[3]

6	(i)	For using Newton's second law	M1
		$120 - 8v - 80 \times 10 \times 0.1 = 80a$	A1
		$\frac{1}{5-v}\frac{dv}{dt} = \frac{1}{10}$ from correct working	A1
			[3]
	(ii)	For separating the variables and attempting to integrate	M1
		$-\ln(5 - v) = \frac{1}{10}t + (C)$	A1
		For using $v(0) = 0$ to find C (or equivalent by using limits) ($C = -\ln 5$)	M1
		For converting the equation from logarithmic to exponential form (allow even if + C omitted) ($5 \div (5 - v) = e^{t/10}$)	M1
		$v = 5(1 - e^{-t/10})$ from correct working	A1
			[5]
	(iii)	For using $v = \frac{dx}{dt}$ and attempting to integrate	M1
		$x = 5(t + 10e^{-t/10}) + (C)$	A1ft
		For using $x(0) = 0$ to find (C) $(= -50)$, then substituting $t = 20$ (or equivalent using limits)	M1
		Length is 56.8 m	A1
		OR	
		For using Newton's second law with $a = v\frac{dv}{dx}$, separating the variables and attempting to integrate	M1
		$-v - 5\ln(5 - v) = \frac{x}{10} + C$	A1
		For using $v = 0$ when $x = 0$ to find C $(= -5\ln 5)$, then substituting $t = 20$ into $v(t)$ $(v(20) = 5(1 - e^{-2}) = 4.3233)$, And finally substituting $v(20)$ into the above equation $(x = -50(1 - e^{-2}) + 50 \times 2 = 50 + 50e^{-2})$	M1
		Length is 56.8m	A1
			[4]