

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)



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1	For using Newton's second law with $a = v^2/r$	M1
	$F = 50\,000 \frac{25^2}{1250}$	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 $\bar{y} = 5$	B1
	For using $\tan \theta = \frac{10}{y}$ or equivalent	M1
	$\theta = 63.4^\circ$	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) $T = \frac{88 \times 0.1}{0.4}$	B1
	For using Newton's second law ($22 - 0.2 \times 10 = 0.2a$)	M1
	(3 term equation needed)	
	Initial acceleration is 100 ms^{-2}	A1
		[3]
	(ii) For using $EPE = \frac{\lambda x^2}{2L}$	$(\frac{88 \times 0.1^2}{2 \times 0.4})$ M1
	Initial elastic energy is 1.1 J	A1
		[2]
	(iii) Change in GPE = $0.2 \times 10 \times 0.1$	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]

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- 4 (i) e.g. For taking moments about BC M1
- Distance of centre of mass of triangular portion is
- $$9.5 + \frac{1}{3} \times 6 (= 11.5) \quad \text{B1}$$
- $$8 \times 9.5 \times 4.75 + \frac{1}{2} \times 8 \times 6 \times 11.5 = (8 \times 9.5 + \frac{1}{2} \times 8 \times 6) \bar{x} \quad \text{A1ft}$$
- 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
- $$(8 \times 15.5) \times 7.75 - (\frac{1}{2} \times 8 \times 6) \times 2 = (124 - 20) \bar{x}_1 \quad \text{A1ft}$$
- $(\bar{x}_1 = 9.13)$ therefore distance is 6.37 cm A1
- [4]
- (ii) For taking moments about A M1
- For LHS of $80(15.5 - 6.37) = T \times 15.5 \sin 30^\circ$ 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) M1
- $(V = 80 - 94.2 \times 0.5)$ or taking moments about B
- $(15.5V = 8 \times 10 \times 6.37)$
- Magnitude of vertical component is 32.9 N A1ft
- [2]

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- 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 M1
- $t = 1.2$ as in (ii)
- 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 B1ft
- (use of ball rebounding at 10 ms^{-1} scores B0)
- 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 $\theta = 0^\circ$ M1
- $-7.2 = x \tan 0^\circ - \frac{gx^2}{2.8^2 \cos^2 0^\circ}$ (allow ft with halving attempt including 10) A1ft
- $x = 9.6 \text{ m}$ 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]

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- 6 (i) For using Newton's second law M1
- $$120 - 8v - 80 \times 10 \times 0.1 = 80a$$
- A1
- $$\frac{1}{5-v} \frac{dv}{dt} = \frac{1}{10} \text{ from correct working}$$
- 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) M1
- $(C = -\ln 5)$
- For converting the equation from logarithmic to exponential form M1
- (allow even if $+C$ omitted) $(5 \div (5-v) = e^{t/10})$
- $$v = 5(1 - e^{-t/10}) \text{ from correct working}$$
- 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 $t = 20$ M1
- (or equivalent using limits)
- 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]