



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)



A AND AS LEVEL - NOVEMBER 20039709/871951For using Newton's second law with $a = v^2/r$ M1 $F = 50\ 000\ \frac{25^2}{1250}$ A1Magnitude of the force is 25 000 NA11For stating or implying that the centre of mass is vertically above the lowest point of the cone, and with $\bar{y} = 5$ B12(i)For stating or implying that the centre of mass is vertically above the lowest point of the cone, and with $\bar{y} = 5$ B12(ii)For using tan $\theta = \frac{10}{y}$ or equivalentM1 $\theta = 63.4^{\circ}$ A13(iii)For using $F < \mu R$ M1 $mg \sin \theta < \mu mg \cos \theta$ A1Alternative for the above 2 marks:For using $\mu = \tan \phi$ where $\phi$ is the angle of frictionM1 $\phi > \theta$ because cone topples without slidingA1Coefficient is greater than 2 (ft on tan $\theta$ in (i))A1N.B. Direct quotation of "topples if $\mu > \tan \theta^n$ (scores B2); $\mu > 2$ (B1)B13(i) $T = \frac{88 \times 0.1}{0.4}$ B1For using EPE = $\frac{2x^2}{2L}$ $(\frac{88 \times 0.1^2}{2 \times 0.4})$ M1(ii)For using EPE = $\frac{2x^2}{2L}$ $(\frac{88 \times 0.1^2}{2 \times 0.4})$ M1(iii)Change in GPE = $0.2 \times 10 \times 0.1$ B1For 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^4A1	Page	1	Mark Scheme Syllabus	Paper
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[3]			Speed is 3 ms <sup>-1</sup>	A1
				[3]

Page 2	Mark Scheme Syllabu	s Paper
	A AND AS LEVEL – NOVEMBER 2003 9709/871	9 5
(i)	e.g. For taking moments about <i>BC</i>	Ν
	Distance of centre of mass of triangular portion is	
	$9.5 + \frac{1}{3} \ge 6$ (= 11.5)	В
	$8 \times 9.5 \times 4.75 + \frac{1}{2} \times 8 \times 6 \times 11.5 = (8 \times 9.5 + \frac{1}{2} \times 8 \times 6) \overline{x}$	А
	Distance is 6.37 cm	А
J.B.	Alternative method e.g. Moments about axis through <i>A</i> perpendicular to <i>AB</i>	M
	Distance of C.O.M. of triangular piece removed is 2	В
	$(8 \times 15.5) \times 7.75 - (\frac{1}{2} \times 8 \times 6) \times 2 = (124 - 20) \overline{x}_1$	А
	$(\bar{x}_1 = 9.13)$ therefore distance is 6.37 cm	А
		[4
(ii)	For taking moments about A For LHS of $80(15.5 - 6.37) = T \times 15.5 \sin 30^{\circ}$ For RHS of above equation Tension is 94.2 N	M A A A
		[4
(iii)	For resolving forces on the lamina vertically (3 term equation) ( $V = 80 - 94.2 \times 0.5$ ) or taking moments about B	N
	$(15.5V = 8 \times 10 \times 6.37)$ Magnitude of vertical component is 32.9 N	А
		[2

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Page 3	Mark Scheme	Syllabus	Paper
	A AND AS LEVEL – NOVEMBER 2003	9709/8719	5

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

[4]

Speed on hitting the wall is  $20 \times 0.8$ (use of ball rebounding at 10 ms<sup>-1</sup> 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)(ii) B1ft M1

Distance is 9.6 m (No ft if rebound velocity = 
$$10 \text{ ms}^{-1}$$
) A1ft

Alternative – speed on hitting the wall is 
$$20 \times 0.8$$
B1ftUse 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 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

F	PM	Τ

Page 4	Mark Scheme Syllab	ous	Paper	
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(i)	For using Newton's second law			N
	$120 - 8v - 80 \times 10 \times 0.1 = 80a$			ŀ
	$\frac{1}{5-v} \frac{dv}{dt} = \frac{1}{10}$ from correct working			A
				[
(ii)	For separating the variables and attempting to integrate			N
	$-\ln(5-v) = \frac{1}{10}t + (C)$			ŀ
	For using $v(0) = 0$ to find C (or equivalent by using limits) (C = -ln5)			ľ
	For converting the equation from logarithmic to exponential form (allow even if + <i>C</i> omitted) $(5 \div (5 - v) = e^{t/10})$	m		ľ
	$v = 5(1 - e^{-t/10})$ from correct working			1
				[
(iii)	For using $v = \frac{dx}{dt}$ and attempting to integrate			ľ
	$x = 5(t + 10e^{-t/10}) + (C)$			ŀ
	For using $x(0) = 0$ to find ( <i>C</i> ) (= -50), then substituting $t = 20$ (or equivalent using limits)			ľ
	Length is 56.8 m			1

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 (= -5ln5), 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]