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Mark Scheme (Results)

June 2011

GCE Mechanics M2 (6678) Paper 1

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EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

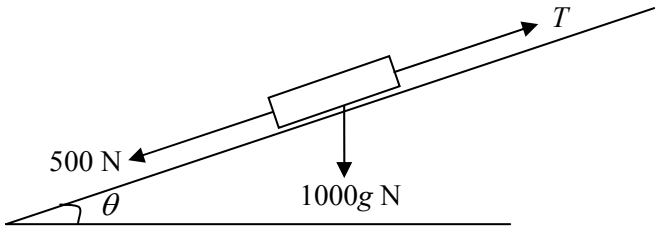
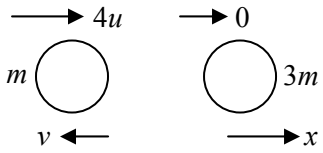
   - **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
   - **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
   - **B** marks are unconditional accuracy marks (independent of M marks)
   - Marks should not be subdivided.

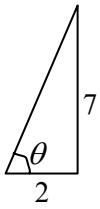
3. Abbreviations

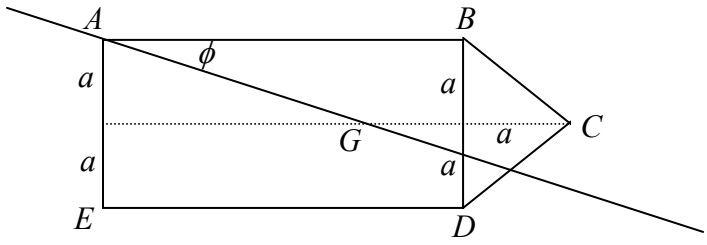
   These are some of the traditional marking abbreviations that will appear in the mark schemes and can be used if you are using the annotation facility on ePEN.

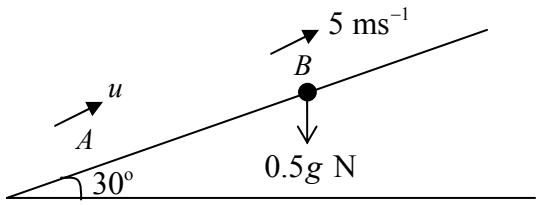
   - bod – benefit of doubt
   - ft – follow through
   - the symbol $\hat{}$ will be used for correct ft
   - cao – correct answer only
   - cso - correct solution only. There must be no errors in this part of the question to obtain this mark
   - isw – ignore subsequent working
   - awrt – answers which round to
   - SC: special case
   - oe – or equivalent (and appropriate)
   - dep – dependent
   - indep – independent
   - dp decimal places
   - sf significant figures
   - * The answer is printed on the paper
   - ⌊ The second mark is dependent on gaining the first mark

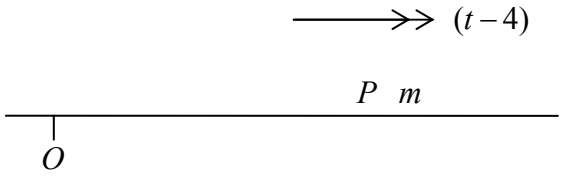
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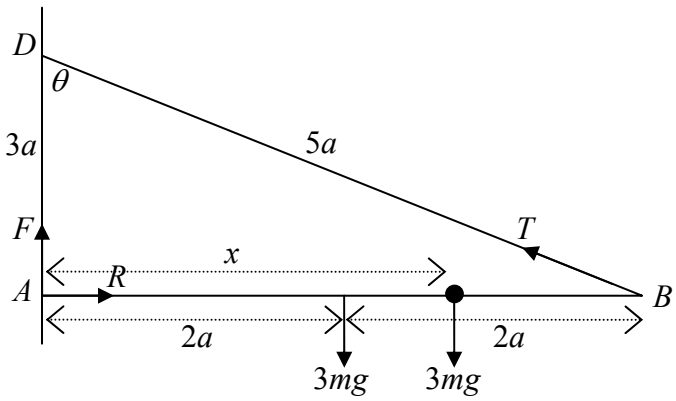
Question Number	Scheme	Marks
1.		
	$12000 = TV$	M1
	$T - 500 - 1000g\sin\theta = 0$	M1 A1
	$V = \dfrac{12000}{500 + 1000 \times 9.8 \times \frac{1}{30}}$	
	$V = 15$ (accept 14.5)	DM1 A1
		(5)
		5
2.		
	$4mu = 3mx - mv$	M1 A1
	$4ue = x + v$	M1 A1
	$4u = 3(4ue - v) - v$	
	$4u = 12ue - 4v$	
	$v = (3e - 1)u$	DM1 A1
	$v > 0 \Rightarrow 3e > 1$	DM1
	$\therefore e > \frac{1}{3}$ **	A1
		(8)
		8

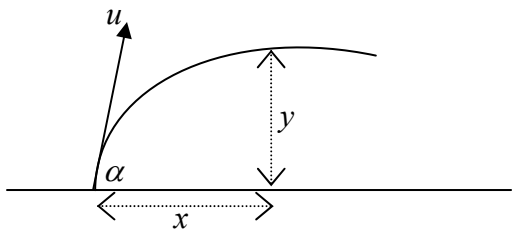
Question Number	Scheme	Marks
3. **(a)**	$\mathbf{I} = m\mathbf{v} - m\mathbf{u}$ $-4\mathbf{i} + 7\mathbf{j} = 0.5(\mathbf{v} - 12\mathbf{i})$ $4\mathbf{i} + 14\mathbf{j} = \mathbf{v}$ Speed $= \sqrt{16 + 196} = \sqrt{212}$ m s^{-1} (14.6 or better)	M1 A1 M1 A1 (4)
(b)	 $\tan\theta = \frac{7}{2}$ $\theta = 74.0....$ $\theta = 74°$	M1 A1ft (2)
(c)	Gain in K.E. $= \frac{1}{2} \times 0.5(212 - 12^2)$, $= 17$ J	M1 A1 (2) **8**

Question Number	Scheme	Marks
4 . **(a)**		
	ABDE | *BCD* | Lamina	
	Mass ratio: $8a^2\rho$ | $a^2\rho$ | $9a^2\rho$	B1
	8 | 1 | 9	
	Dist of C of M From AE: 2a | $4\frac{1}{3}a$ | $\bar{x}$	B1
	$8\times 2a+1\times\frac{13}{3}a=9\bar{x}$	M1
	$\bar{x}=\frac{61}{27}a$ (2.26*a*)	A1 (4)
(b)	$\tan\phi=\frac{a}{\frac{61}{27}a}=\frac{27}{61}$	M1 A1 ft
	$\phi=23.87...=24°$ (accept 23.9), 0.417 radians	A1 (3) **7**

Question Number	Scheme	Marks
5. **(a)**		
	$0.5g \times 2\sin 30 = \frac{1}{2} \times 0.5u^2 - \frac{1}{2} \times 0.5 \times 5^2$	M1 A1
	$\frac{1}{4}u^2 = 0.5g + \frac{1}{2} \times 0.5 \times 5^2$	
	$u = 6.7$ m s^{-1} (accept 6.68)	DM1 A1
		(4)
(b)	$R = 0.5g\cos 30$	B1
	$F = 0.5g\cos 30 \times \mu$	M1
	Work done by friction $= 1.5F$	
	$\frac{1}{2} \times 0.5 \times 5^2 = 1.5F + 0.5g \times 1.5\sin 30$	M1 A1 A1
	$\mu = \frac{\frac{1}{2} \times 0.5 \times 5^2 - 0.5g \times 1.5\sin 30}{0.5g\cos 30 \times 1.5}$	
	$\mu = 0.40$ (accept 0.4 or 0.405)	A1
		(6)
		10

Question Number	Scheme	Marks
6. **(a)**	 $\frac{dv}{dt} = t - 4$ $v = \frac{1}{2}t^2 - 4t(+c)$ $t = 0 \quad v = 6 \quad \Rightarrow c = 6$ $\therefore v = \frac{1}{2}t^2 - 4t + 6$	 M1 A1 M1 A1 (4)
(b)	$v = 0 \quad 0 = t^2 - 8t + 12$ $(t-6)(t-2) = 0$ $t = 6 \quad t = 2$	M1 DM1 A1 (3)
(c)	$x = \frac{t^3}{6} - 2t^2 + 6t + k$ $x_6 - x_2 = \frac{6^3}{6} - 2\times 6^2 + 6^2 + k$ $-\left(\frac{2^3}{6} - 2\times 2^2 + 6\times 2 + k\right)$ $= -5\frac{1}{3}$ $\therefore$ Distance is $5\frac{1}{3}$m	M1 A1 ft DM1 A1 (4) **11**

Question Number	Scheme	Marks
7. **(a)**	 M(A) $3mg \times 2a + 3mgx = T\cos\theta \times 4a$ $= \frac{12}{5}aT$ $\frac{12}{5}aT = 6mga + 3mgx$ $T = \frac{25}{4}mg$ $\frac{12}{5}a \times \frac{25}{4}mg = 6mga + 3mgx$ $15a = 6a + 3x$ $x = 3a$ **	M1 A2,1,0 M1 A1 (5)
(b)	R$(\rightarrow)$ $R = T\sin\theta$ $= \frac{25}{4}mg \times \frac{4}{5}$ $= 5mg$ **	M1 A1 A1 (3)
(c)	R$(\uparrow)$ $F + \frac{25}{4}mg \times \frac{3}{5} = 3mg + 3mg$ $F = 6mg - \frac{15}{4}mg = \frac{9}{4}mg$ $\mu = \frac{F}{R} = \frac{\frac{9}{4}mg}{5mg} = \frac{9}{20}$	M1 A2,1,0 DM1 A1 (5) **13**

Question Number	Scheme	Marks
8. **(a)**		
	Horiz: $x = u\cos\alpha t$	B1
	Vert: $y = u\sin\alpha t - \frac{1}{2}gt^2$	M1
	$y = u\sin\alpha \times \frac{x}{u\cos\alpha} - \frac{1}{2}g \times \frac{x^2}{u^2\cos^2\alpha}$	DM1
	$y = x\tan\alpha - \frac{gx^2}{2u^2\cos^2\alpha}$ **	A1
		(4)
(b)	$y = -7$: $-7 = \tan 45x - \frac{gx^2}{2\times 7^2\cos^2 45}$	M1 A1
	$-7 = x - \frac{9.8x^2}{7^2}$	
	$-7 = x - \frac{x^2}{5}$	M1
	$x^2 - 5x - 35 = 0$	
	$x = \frac{5 \pm \sqrt{25 + 4\times 35}}{2}$	M1
	$x = 8.92$ or 8.9	A1
		(5)
(c)	Time to travel 8.922 m horizontally $= \frac{8.922}{7\cos 45} = 1.802...$s	M1
	$v = \frac{8.922}{1.402}$	M1 A1 ft
	$= 6.36$ or 6.4 $\left(\text{m s}^{-1}\right)$	A1
		(4)
		13

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