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Mark Scheme (Results)

Summer 2012

GCE Mechanics M3
(6679) Paper 1

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Summer 2012
6679 Mechanics 3
Mark Scheme

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

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 $\surd$ 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

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

General Principles for Mechanics Marking

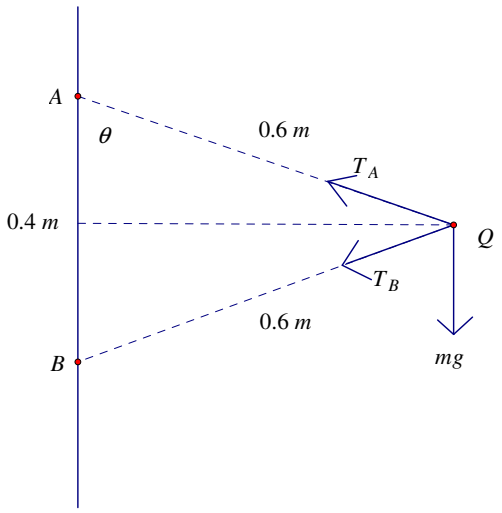
Usual rules for M marks: correct no. of terms; dim correct; all terms that need resolving (i.e. multiplied by cos or sin) are resolved.
Omission or extra g in a resolution is accuracy error not method error.
Omission of mass from a resolution is method error.
Omission of a length from a moments equation is a method error.
Omission of units or incorrect units is not (usually) counted as an accuracy error.
DM indicates a dependent method mark i.e. one that can only be awarded if a previous specified method mark has been awarded.
Any numerical answer which comes from use of g = 9.8 should be given to 2 or 3 SF.
Use of g = 9.81 should be penalised once per (complete) question.
N.B. Over-accuracy or under-accuracy of correct answers should only be penalised *ONCE* per complete question.
However, premature approximation should be penalised every time it occurs.
MARKS MUST BE ENTERED IN THE SAME ORDER AS THEY APPEAR ON THE MARK SCHEME.

In all cases, if the candidate clearly labels their working under a particular part of a question i.e. (a) or (b) or (c),……then that working can only score marks for that part of the question.

Accept column vectors in all cases.

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6679 Mechanics M3
Mark Scheme

Question Number	Scheme	Marks
1(a)	Use of $a = v\frac{\mathrm{d}v}{\mathrm{d}x}$ or $a = \frac{\mathrm{d}}{\mathrm{d}x}\left(\frac{1}{2}v^2\right)$	M1
	$a = 2e^{-x}.-2e^{-x}$ or $v^2 = 4e^{-2x}$	A1
	$a = -4e^{-2x}$	A1
		(3)
(b)	Separate the variables and attempt to integrate: $\int 2\mathrm{d}t = \int e^x \mathrm{d}x$	M1
	$2t = e^x + C$	A1A1
	t=0, x=0 $\Rightarrow C$=-1, $2t = e^x - 1$	M1A1
	$x = \ln(2t+1)$	A1
		(6)
		9
2(a)	$T = \frac{2\pi}{\omega} \Rightarrow \omega = 4$	B1
	Use of $v^2 = \omega^2\left(v^2 - x^2\right)$, or $v = a\omega$	M1
	a = 1.5 (m)	A1
		(3)
(b)	Use of max. accn. = $\omega^2 a$	M1
	24 ms^{-2}	A1
		(2)
(c)	$x = a\sin\omega t$ with their values for a & ω	B1
	$1 = 1.5\sin 4t$ (with their 1.5 & 4) and attempt to solve for t	M1
	t = 0.18 (or awrt)	A1
		(3)
		8

Question Number	Scheme	Marks
3		
	$\cos\theta = \frac{0.2}{0.6}\left(=\frac{1}{3}\right)$	B1
	Resolve vertically:	M1
	$T_A\cos\theta = T_B\cos\theta + mg \quad (T_A = T_B + 3mg)$	A2,1,0
	Acceleration towards the centre:	M1
	$T_A\sin\theta + T_B\sin\theta = m\times 0.6\sin\theta\times\omega^2 \quad \left(T_A + T_B = 5\times\frac{3}{5}\times 100 = 300\right)$	A2,1,0
	Substitute values for ω and trig functions and solve to find T_A or T_B	M1
	$T_B + 147 + T_B = 300, \quad 2T_B = 300 - 147 = 153$	A1,A1
	$T_A = 223.5(\text{N}) \quad , \quad T_B = 76.5(\text{N})$	
	$T_A = 224$ or 220 $\quad T_B = 76$	
	$T_B = 76.5$ or 77 $\quad T_A = 223$	
		(10)
		10

Question Number	Scheme	Marks
4 (a)		

	volume	Mass ratio	C of M from V
Large cone	$\frac{1}{3}\pi a^2.2a=\frac{2}{3}\pi a^3$	2	$\frac{3}{4}\times 2a=\frac{3}{2}a$
Small cone	$\frac{1}{3}\pi a^2.a=\frac{1}{3}\pi a^3$	1	$a+\frac{3}{4}a=\frac{7}{4}a$
S	$\frac{1}{3}\pi a^2.a=\frac{1}{3}\pi a^3$	1	D

B1, B1

$1\times D=2\times\frac{3}{2}a-1\times\frac{7}{4}a$

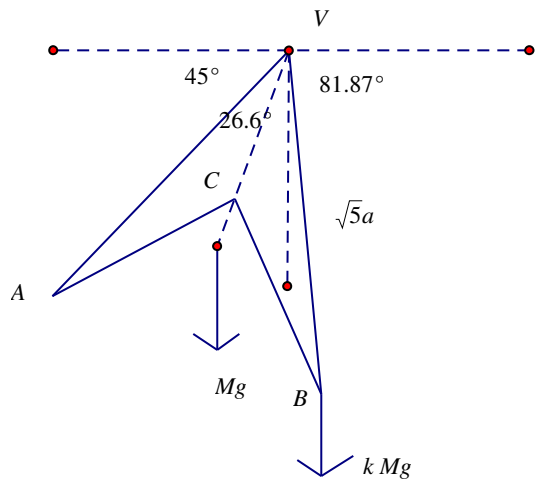
$=\frac{12-7}{4}a=\frac{5}{4}a$ **

M1A1

A1

(5)

(b)



$45°+26.6°(=71.6°)$, $(81.8698.....=)81.9°$

Take moments about V:

M1

A2

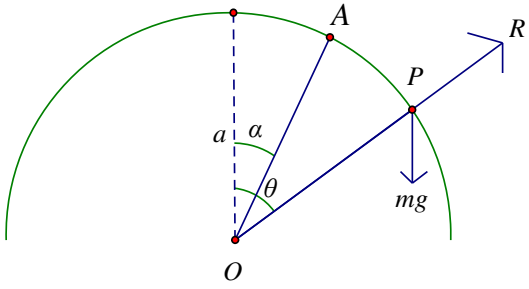
$Mg\times\frac{5}{4}a\times\cos 71.6=kMg\times\sqrt{5}a\times\cos 81.9$

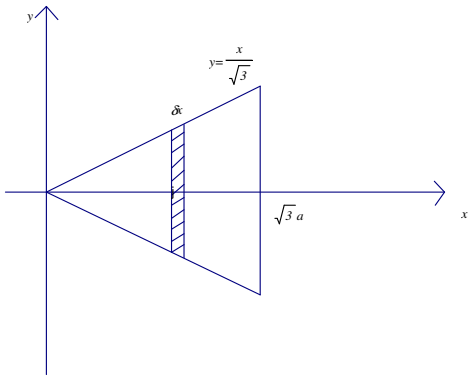
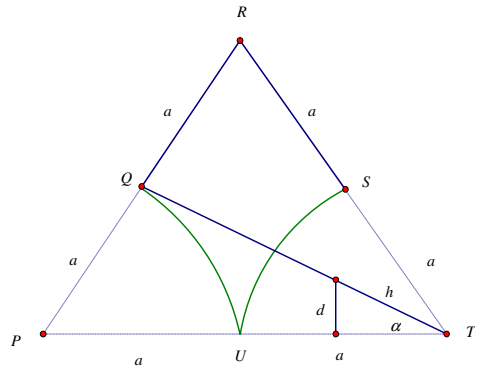
$k=\frac{5\cos 71.6}{4\sqrt{5}\cos 81.9}=1.25$

M1A1

(5)

10

Question Number	Scheme	Marks
5(a)		
	Conservation of energy : Loss in GPE = gain in KE $mga(\cos\alpha - \cos\theta) = \frac{1}{2}mv^2$	M1 A2,1,0
	Substitute for $\cos\alpha$ and rearrange to **given answer**: $v^2 = \frac{2mga}{m}\left(\frac{3}{5} - \cos\theta\right) = \frac{2ga}{5}(3 - 5\cos\theta)$ *	A1 (4)
(b)	Considering the acceleration towards the centre of the hemisphere: $mg\cos\theta - R = \frac{mv^2}{a}$	M1 A2,1,0
	Substitute for v^2 to form expression for R: $R = mg\cos\theta - \frac{mv^2}{a} = mg(3\cos\theta - 2\cos\alpha)\left(= mg\left(3\cos\theta - \frac{6}{5}\right)\right)$	DM1 A1
	Loses contact with the surface when $R = 0$ $\cos\theta = \frac{2}{5}$	M1 A1
	$v^2 = \frac{2ga}{5}$, $v = \sqrt{\frac{2ga}{5}}$	A1 (8) **12**
Alt:	$R = 0 \Rightarrow mg\cos\theta = \frac{mv^2}{a}$	DM1
	$\cos\theta = \frac{v^2}{ga}$	A1
	Substitute in given (a) $v^2 = \frac{2ga}{5}\left(3 - 5\frac{v^2}{ga}\right)$	M1
	$v^2 = \frac{6ga}{5} - 2v^2$, $3v^2 = \frac{6ga}{5}$	A1
	$v = \sqrt{\frac{2ga}{5}}$	A1

Question Number	Scheme	Marks
6(a)		
	Mass of lamina = $\rho\frac{1}{2}\times 2a\times\sqrt{3}a=\sqrt{3}\rho a^2$	B1
	$\sum\rho x\times\frac{2x}{\sqrt{3}}\times\delta x=\rho\int_0^{\sqrt{3}a}\frac{2x^2}{\sqrt{3}}\mathrm{d}x$	M1
	$=\rho\left[\frac{2x^3}{3\sqrt{3}}\right]_0^{\sqrt{3}a}$	A1
	$=\rho\frac{2\times 3\sqrt{3}a^3}{3\sqrt{3}}=2\rho a^3$	A1
	Distance from vertex = $\frac{2\rho a^3}{\sqrt{3}\rho a^2}=\frac{2}{3}a\sqrt{3}$ **	M1A1
		(6)
(b)		
	Area of each sector = $\frac{1}{6}\pi a^2$	B1
	Using sector formula, $d=h\sin\alpha=\frac{2a\sin\alpha}{3\alpha}\sin\alpha=\frac{a}{3\frac{\pi}{6}}\times\frac{1}{2}=\frac{a}{\pi}$	B2,1,0
	Taking moments: $\left(\sqrt{3}a^2-2\times\frac{\pi a^2}{6}\right)D=\sqrt{3}a^2\times\frac{\sqrt{3}a}{3}-2\times\frac{\pi a^2}{6}\times\frac{a}{\pi}$	M1A1

Question Number	Scheme	Marks
	$D = \dfrac{\frac{2a^3}{3}}{\left(\sqrt{3} - \frac{\pi}{3}\right)a^2} = \dfrac{2a}{3\sqrt{3} - \pi}$ **	A1 (6) **12**

Question Number	Scheme	Marks
7(a)	Use of $T = \dfrac{\lambda x}{a} = mg$	M1
	$T = \dfrac{24.5x}{0.75} = 0.5g$	A1
	$x = \dfrac{0.75 \times 0.5g}{24.5} = 0.15$, $AE = 0.75 + 0.15 = 0.9\,(\text{m})$ **(**)**	A1
		(3)
(b)	Using gain in EPE = loss in GPE	M1
	$\dfrac{\lambda x^2}{2a} = \dfrac{24.5x^2}{1.5} = ...$	A1
	$..... = 0.5g(0.75 + x)$	A1
	Form quadratic in x and attempt to solve for x :	DM1
	$24.5x^2 = 5.5125 + 7.35x$, $24.5x^2 - 7.35x - 5.5125 = 0$, $x = \dfrac{7.35 \pm \sqrt{7.35^2 + 4 \times 24.5 \times 5.5125}}{49}$ (or $40x^2 - 12x - 9 = 0$, $x = \dfrac{12 \pm \sqrt{144 + 3600}}{80}$)	
	$x = 0.647...\,(\text{m})$ $\quad AC \approx 1.4\,(\text{m})$	A1
		(5)
(c)	Using $F = ma$ and displacement x from E:	M1
	$0.5g - \dfrac{24.5(x + 0.15)}{0.75} = 0.5\ddot{x}$	A2,1,0
	$\ddot{x} = -\dfrac{196}{3}x$, so SHM	A1
(d)	Max speed = their a x their ω	M1
		(4)
	$= (0.647 - 0.15) \times \sqrt{\dfrac{196}{3}}$	
	$\approx 4.0\ \text{ms}^{-1}$ (4.02)	A1
		(2)
		14

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