

Mark Scheme (Results)

Summer 2012

GCE Mechanics M3
(6679) Paper 1

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the world's leading learning company. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information, please visit our website at www.edexcel.com.

Our website subject pages hold useful resources, support material and live feeds from our subject advisors giving you access to a portal of information. If you have any subject specific questions about this specification that require the help of a subject specialist, you may find our Ask The Expert email service helpful.

www.edexcel.com/contactus

Pearson: helping people progress, everywhere

Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Summer 2012

Publications Code UA032681

All the material in this publication is copyright

© Pearson Education Ltd 2012

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 \checkmark 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
 - \square 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.

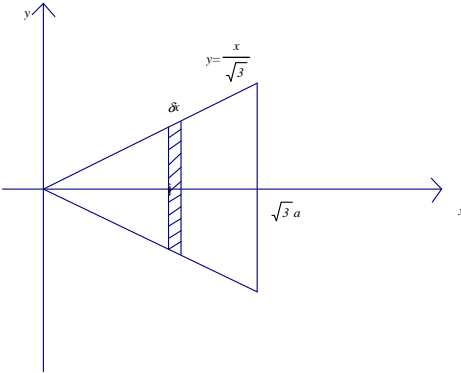
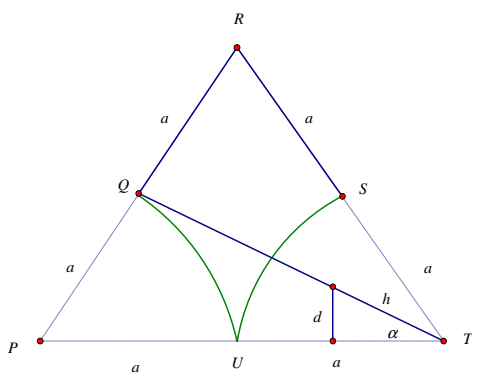
Summer 2012
6679 Mechanics M3
Mark Scheme

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

Question Number	Scheme	Marks
3	<div data-bbox="300 331 794 833" data-label="Diagram"> </div> <p data-bbox="284 891 513 967"> $\cos \theta = \frac{0.2}{0.6} \left(= \frac{1}{3} \right)$ </p> <p data-bbox="284 981 523 1012">Resolve vertically:</p> <p data-bbox="284 1016 855 1057"> $T_A \cos \theta = T_B \cos \theta + mg \quad (T_A = T_B + 3mg)$ </p> <p data-bbox="284 1061 699 1093">Acceleration towards the centre:</p> <p data-bbox="284 1102 1168 1182"> $T_A \sin \theta + T_B \sin \theta = m \times 0.6 \sin \theta \times \omega^2 \quad \left(T_A + T_B = 5 \times \frac{3}{5} \times 100 = 300 \right)$ </p> <p data-bbox="284 1191 1152 1223">Substitute values for ω and trig functions and solve to find T_A or T_B</p> <p data-bbox="284 1227 868 1258"> $T_B + 147 + T_B = 300, \quad 2T_B = 300 - 147 = 153$ </p> <p data-bbox="284 1272 721 1303"> $T_A = 223.5(\text{N}) \quad , \quad T_B = 76.5(\text{N})$ </p> <p data-bbox="284 1317 635 1348"> $T_A = 224 \text{ or } 220 \quad T_B = 76$ </p> <p data-bbox="284 1361 651 1393"> $T_B = 76.5 \text{ or } 77 \quad T_A = 223$ </p>	<p data-bbox="1286 891 1321 922">B1</p> <p data-bbox="1286 981 1327 1012">M1</p> <p data-bbox="1286 1016 1375 1048">A2,1,0</p> <p data-bbox="1286 1061 1327 1093">M1</p> <p data-bbox="1286 1102 1375 1133">A2,1,0</p> <p data-bbox="1286 1191 1327 1223">M1</p> <p data-bbox="1286 1227 1375 1258">A1,A1</p> <p data-bbox="1426 1415 1487 1482" style="text-align: right;"> (10) 10 </p>

Question Number	Scheme				Marks
4 (a)		volume	Mass ratio	C of M from V	B1, B1 M1A1 A1 <

Question Number	Scheme	Marks
5(a)	<div data-bbox="501 322 1027 604" data-label="Image"> </div> <p>Conservation of energy : Loss in GPE = gain in KE</p> $mga(\cos \alpha - \cos \theta) = \frac{1}{2}mv^2$ <p>Substitute for $\cos \alpha$ and rearrange to given answer:</p> $v^2 = \frac{2mga}{m} \left(\frac{3}{5} - \cos \theta \right) = \frac{2ga}{5} (3 - 5 \cos \theta) \quad *$	<p>M1 A2,1,0</p> <p>A1</p> <p>(4)</p>
(b)	<p>Considering the acceleration towards the centre of the hemisphere:</p> $mg \cos \theta - R = \frac{mv^2}{a}$ <p>Substitute for v^2 to form expression for R:</p> $R = mg \cos \theta - \frac{mv^2}{a} = mg(3 \cos \theta - 2 \cos \alpha) \left(= mg \left(3 \cos \theta - \frac{6}{5} \right) \right)$ <p>Loses contact with the surface when $R = 0$</p> $\cos \theta = \frac{2}{5}$ $v^2 = \frac{2ga}{5}, \quad v = \sqrt{\frac{2ga}{5}}$	<p>M1 A2,1,0</p> <p>DM1 A1</p> <p>M1 A1</p> <p>A1</p> <p>(8) 12</p>
Alt:	$R = 0 \Rightarrow mg \cos \theta = \frac{mv^2}{a}$ $\cos \theta = \frac{v^2}{ga}$ <p>Substitute in given (a) $v^2 = \frac{2ga}{5} \left(3 - 5 \frac{v^2}{ga} \right)$</p> $v^2 = \frac{6ga}{5} - 2v^2, \quad 3v^2 = \frac{6ga}{5}$ $v = \sqrt{\frac{2ga}{5}}$	<p>DM1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>A1</p>

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

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

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

Further copies of this publication are available from
Edexcel Publications, Adamsway, Mansfield, Notts, NG18 4FN

Telephone 01623 467467

Fax 01623 450481

Email publication.orders@edexcel.com

Order Code UA032681 Summer 2012

For more information on Edexcel qualifications, please visit our website
www.edexcel.com

Pearson Education Limited. Registered company number 872828
with its registered office at Edinburgh Gate, Harlow, Essex CM20 2JE



Llywodraeth Cynulliad Cymru
Welsh Assembly Government

