

# Mark Scheme (Results)

June 2011

GCE Mechanics M2 (6678) Paper 1

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## EDEXCEL GCE MATHEMATICS

### General Instructions for Marking

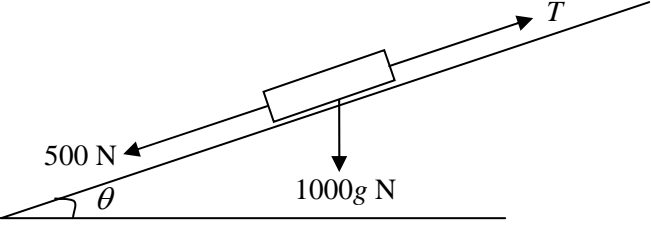
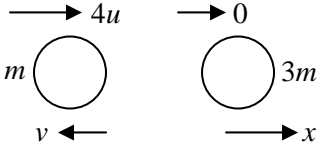
1. The total number of marks for the paper is 75.
2. The Edexcel Mathematics mark schemes use the following types of marks:
  - **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
  - **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
  - **B** marks are unconditional accuracy marks (independent of M marks)
  - Marks should not be subdivided.

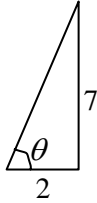
### 3. Abbreviations

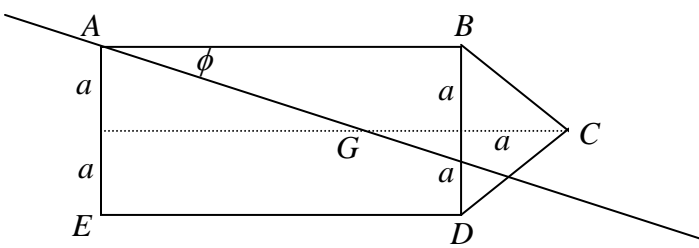
These are some of the traditional marking abbreviations that will appear in the mark schemes and can be used if you are using the annotation facility on ePEN.

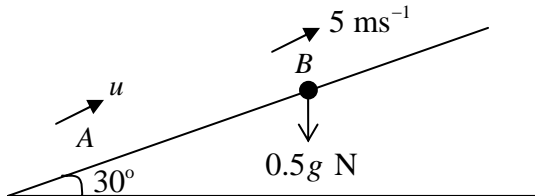
- bod – benefit of doubt
- ft – follow through
- the symbol  $\checkmark$  will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- 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

June 2011  
6678 Mechanics M2  
Mark Scheme

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

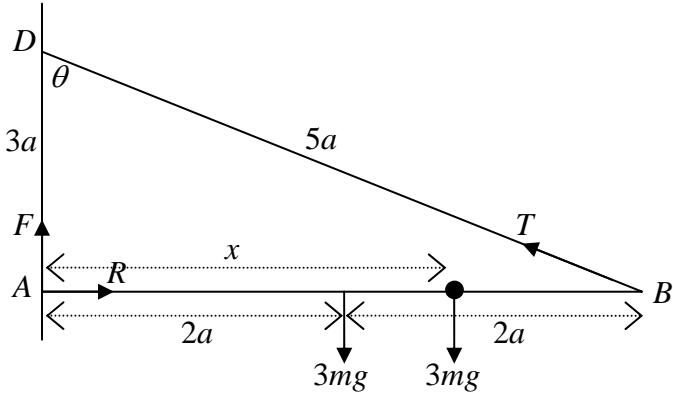
Question Number	Scheme	Marks
<b>3.</b> <b>(a)</b>	$\mathbf{I} = m\mathbf{v} - m\mathbf{u}$ $-4\mathbf{i} + 7\mathbf{j} = 0.5(\mathbf{v} - 12\mathbf{i})$ $4\mathbf{i} + 14\mathbf{j} = \mathbf{v}$ $\text{Speed} = \sqrt{16 + 196} = \sqrt{212} \text{ m s}^{-1} \text{ (14.6 or better)}$	M1 A1 M1 A1 (4)
<b>(b)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

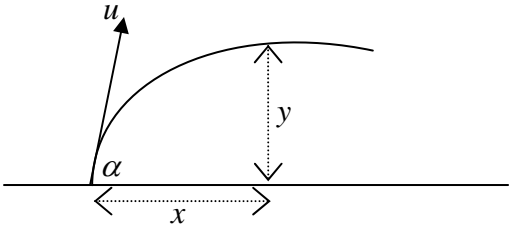
Question Number	Scheme	Marks																								
<p><b>4.</b> <b>(a)</b></p>	 <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th style="text-align: center;"><i>ABDE</i></th> <th style="text-align: center;"><i>BCD</i></th> <th style="text-align: center;">  </th> <th style="text-align: center;">  </th> <th style="text-align: center;"><i>Lamina</i></th> </tr> </thead> <tbody> <tr> <td>Mass ratio</td> <td style="text-align: center;"><math>8a^2\rho</math></td> <td style="text-align: center;"><math>a^2\rho</math></td> <td></td> <td></td> <td style="text-align: center;"><math>9a^2\rho</math></td> </tr> <tr> <td></td> <td style="text-align: center;">8</td> <td style="text-align: center;">1</td> <td></td> <td></td> <td style="text-align: center;">9</td> </tr> <tr> <td>Dist of C of M From AE</td> <td style="text-align: center;"><math>2a</math></td> <td style="text-align: center;"><math>4\frac{1}{3}a</math></td> <td></td> <td></td> <td style="text-align: center;"><math>\bar{x}</math></td> </tr> </tbody> </table> $8 \times 2a + 1 \times \frac{13}{3}a = 9\bar{x}$ $\bar{x} = \frac{61}{27}a \quad (2.26a)$		<i>ABDE</i>	<i>BCD</i>			<i>Lamina</i>	Mass ratio	$8a^2\rho$	$a^2\rho$			$9a^2\rho$		8	1			9	Dist of C of M From AE	$2a$	$4\frac{1}{3}a$			$\bar{x}$	<p style="text-align: right;">B1</p> <p style="text-align: right;">B1</p> <p style="text-align: right;">M1</p> <p style="text-align: right;">A1</p> <p style="text-align: right;">(4)</p>
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Mass ratio	$8a^2\rho$	$a^2\rho$			$9a^2\rho$																					
	8	1			9																					
Dist of C of M From AE	$2a$	$4\frac{1}{3}a$			$\bar{x}$																					
<p><b>(b)</b></p>	$\tan \phi = \frac{a}{\frac{61}{27}a} = \frac{27}{61}$ $\phi = 23.87\dots = 24^\circ \quad (\text{accept } 23.9), 0.417 \text{ radians}$	<p style="text-align: right;">M1 A1 ft</p> <p style="text-align: right;">A1</p> <p style="text-align: right;">(3)</p> <p style="text-align: right;"><b>7</b></p>																								

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

Question Number	Scheme	Marks
<b>6.</b> <b>(a)</b>	$\begin{array}{c} \longrightarrow \gg (t-4) \\ P \quad m \\ \hline O \end{array}$ $\frac{dv}{dt} = t - 4$ $v = \frac{1}{2}t^2 - 4t (+c)$ $t = 0 \quad v = 6 \quad \Rightarrow c = 6$ $\therefore v = \frac{1}{2}t^2 - 4t + 6$	   M1 A1 M1 A1 (4)
<b>(b)</b>	$v = 0 \quad 0 = t^2 - 8t + 12$ $(t-6)(t-2) = 0$ $t = 6 \quad t = 2$	M1 DM1 A1 (3)
<b>(c)</b>	$x = \frac{t^3}{6} - 2t^2 + 6t + k$ $x_6 - x_2 = \frac{6^3}{6} - 2 \times 6^2 + 6 \times 6 + k$ $- \left( \frac{2^3}{6} - 2 \times 2^2 + 6 \times 2 + k \right)$ $= -5 \frac{1}{3}$ $\therefore \text{Distance is } 5 \frac{1}{3} \text{ m}$	M1 A1 ft DM1 A1 (4) <b>11</b>



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

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



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