

# Mark Scheme (Results) January 2011

GCE

## GCE Mechanics M2 (6678) Paper 1

Edexcel is one of the leading examining and awarding bodies in the UK and throughout the world. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers.

Through a network of UK and overseas offices, Edexcel's centres receive the support they need to help them deliver their education and training programmes to learners.

For further information, please call our GCE line on 0844 576 0025, our GCSE team on 0844 576 0027, or visit our website at [www.edexcel.com](http://www.edexcel.com).

If you have any subject specific questions about the content of this Mark Scheme that require the help of a subject specialist, you may find our **Ask The Expert** email service helpful.

Ask The Expert can be accessed online at the following link:

<http://www.edexcel.com/Aboutus/contact-us/>

January 2011

Publications Code UA026580

All the material in this publication is copyright

© Edexcel Ltd 2011

## 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.

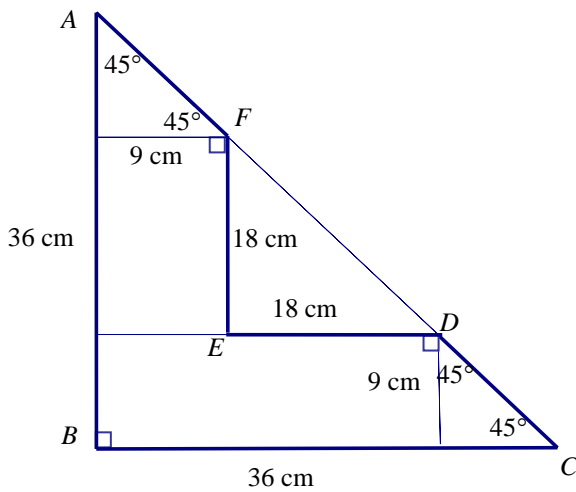
- bod - benefit of doubt
- ft - follow through
- the symbol  $\surd$  will be used for correct ft
- cao - correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw - ignore subsequent working
- awrt - answers which round to
- SC: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





5.

(a)



Divide the shape into usable areas, e.g.:

Shape	C of mass	Units of mass
Rectangle 27 x 9	(13.5,4.5)	243 (6)
Right hand triangle	(30,3)	40.5 (1)
Top triangle	(3,30)	40.5 (1)
Rectangle 9 x 18	(4.5,18)	162 (4)

Mass ratios  
Centres of mass

B1  
B1

Take moments about AB:

$$6 \times 13.5 + 1 \times 30 + 4 \times 4.5 + 1 \times 3 = 132 = 12\bar{x},$$

$$\bar{x} = 11 \text{ (cm) solve for } x \text{ (or } y) \text{ co-ord}$$

$$\bar{y} = 11 \text{ (cm) using the symmetry}$$

M1  
A(2, 1, 0)

A1  
B1ft

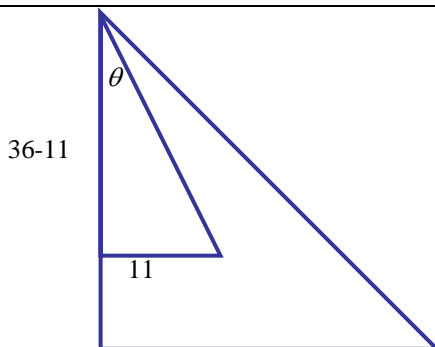
Alternative:

Shape	C of mass	Units of mass
Small triangle	(12,12)	.5 x 18 x 18
Large triangle	(15,15)	.5 x 36 x 36

$$\frac{1}{2} \times 36 \times 36 \times 12 - \frac{1}{2} \times 18 \times 18 \times 15 = \frac{1}{2} (36 \times 36 - 18 \times 18) \bar{x} \text{ etc.}$$

(7)

(b)



$$\tan \theta = \frac{\bar{x}}{36 - \bar{y}}$$

$$\tan \theta = \frac{11}{25} = 0.44$$

$$\theta = 24^\circ$$

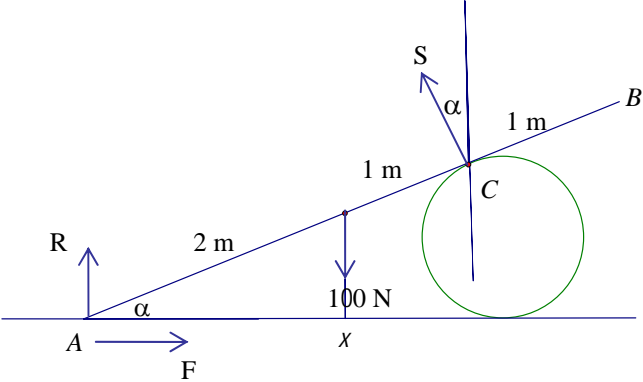
M1

A1ft

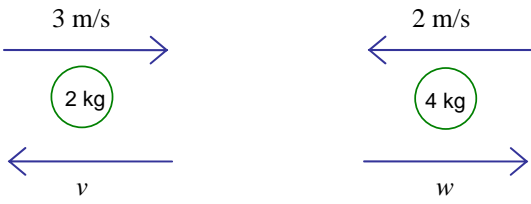
A1

(3)  
[10]

6.	(a)	Using $s = ut + \frac{1}{2}at^2$ clear $\mathbf{r} = (3t)\mathbf{i} + (10 + 5t - 4.9t^2)\mathbf{j}$	Method must be  Answer given	M1  A1 A1  (3)
	(b)	$\mathbf{j}$ component = 0: $10 + 5t - 4.9t^2$ quadratic formula: $t = \frac{5 \pm \sqrt{25 + 196}}{9.8} = \frac{5 \pm \sqrt{221}}{9.8}$ $T = 2.03(\text{s}), 2.0(\text{s})$ positive solution only.		M1 DM1  A1  (3)
	(c)	Differentiating the position vector (or working from first principles) $\mathbf{v} = 3\mathbf{i} + (5 - 9.8t)\mathbf{j}$ ( $\text{ms}^{-1}$ )		M1 A1  (2)
	(d)	At B the $\mathbf{j}$ component of the velocity is the negative of the $\mathbf{i}$ component: $5 - 9.8t = -3, 8 = 9.8t,$  $t = 0.82$		M1 A1  (2)
	(e)	$\mathbf{v} = 3\mathbf{i} - 3\mathbf{j}$ , speed = $\sqrt{3^2 + 3^2} = \sqrt{18} = 4.24 (\text{m s}^{-1})$		M1A1  (2) [12]

Question Number	Scheme	Marks
7.	 <p>Taking moments about A:</p> $3S = 100 \times 2 \times \cos \alpha$ <p>Resolving vertically:</p> $R + S \cos \alpha = 100$ <p>Resolving horizontally:</p> $S \sin \alpha = F$ <p>(Most alternative methods need 3 independent equations, each one worth M1A1. Can be done in 2 e.g. if they resolve horizontally and take moments about X then <math>R \times 2 \times \cos \alpha = S \times (3 - 2 \times \cos^2 \alpha)</math> scores M2A2)</p> <p>Substitute trig values to obtain correct values for F and R (exact or decimal equivalent).</p> $\left( S = \frac{200\sqrt{8}}{9} \right), R = 100 - \frac{1600}{27} = \frac{1100}{27} \approx 40.74, F = \frac{200\sqrt{8}}{27} \approx 20.95\dots$ $F \leq \mu R, 200\sqrt{8} \leq \mu \times 1100, \mu \geq \frac{200\sqrt{8}}{1100} = \frac{2\sqrt{8}}{11}.$ <p>Least possible <math>\mu</math> is 0.514 (3sf), or exact.</p>	<p>M1 A1</p> <p>M1 A1</p> <p>M1 A1</p> <p>DM1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>[10]</p>



Question Number	Scheme	Marks
8. (a)	<p>KE lost : <math>\frac{1}{2} \times m \times 36 - \frac{1}{2} \times m \times v^2 = 64</math></p> <p>Restitution: <math>v = 1/3 \times 6 = 2</math></p> <p>Substitute and solve for m: <math>\frac{1}{2} \times m \times 36 - \frac{1}{2} \times m \times 4 = 64 = 16m</math></p> <p style="text-align: right;"><math>m = 4</math>    answer given</p>	<p>M1A1</p> <p>M1A1</p> <p>DM1</p> <p>A1</p> <p style="text-align: right;">(6)</p>
(b)	<div style="text-align: center;">  </div> <p>Conservation of momentum: <math>6 - 8 = 4w - 2v</math>      their "2"</p> <p>Restitution: <math>v + w = \frac{1}{3}(2 + 3)</math>      their "2"</p> <p><math>v = \frac{5}{3} - w</math></p> <p>Solve for w: <math>-2 = 4w - 2(\frac{5}{3} - w) = 6w - \frac{10}{3}</math></p> <p><math>\frac{4}{3} = 6w</math></p> <p><math>(w = 4/18 = 2/9 \text{ m s}^{-1})</math></p> <p><math>w &gt; 0 \Rightarrow</math> will collide with the wall again</p>	<p>M1A1ft</p> <p>M1A1ft</p> <p>DM1</p> <p>A1</p> <p>A1</p> <p style="text-align: right;">(7) [13]</p>

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

Telephone 01623 467467  
Fax 01623 450481

Email [publications@linneydirect.com](mailto:publications@linneydirect.com)

Order Code UA026580 January 2011

For more information on Edexcel qualifications, please visit [www.edexcel.com/quals](http://www.edexcel.com/quals)

Edexcel Limited. Registered in England and Wales no.4496750  
Registered Office: One90 High Holborn, London, WC1V 7BH