

Mark Scheme (Results)

Summer 2013

GCE Mechanics 1 (6677/01R)

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## 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.
- 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:

- 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
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.
  5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.
  6. If a candidate makes more than one attempt at any question:
    - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
    - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.
  7. Ignore wrong working or incorrect statements following a correct answer.
  8. In some instances, the mark distributions (e.g. M1, B1 and A1) printed on the candidate's response may differ from the final mark scheme

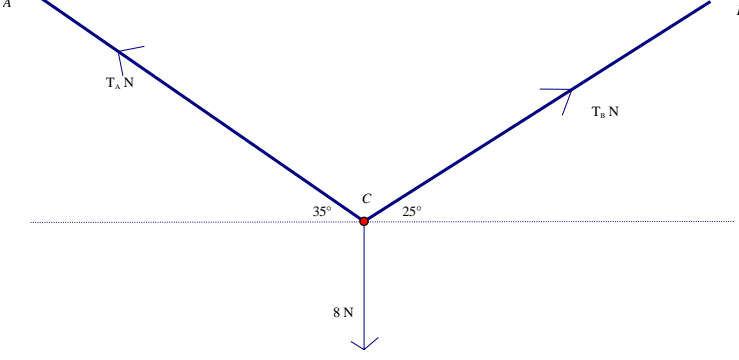
### General Rules for Marking Mechanics

- 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.
- 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.
  - Misreads – if a misread does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, bearing in mind that after a misread, the subsequent A marks affected are treated as A ft.

Question Number	Scheme	Marks
<p><b>1(a)</b></p> <p><b>(b)</b></p>	 <p> <math>2v + 10 = 14</math>  <math>v = 2 \text{ m s}^{-1}</math> </p> <p> <math>3w + 18 = 14</math>  <math>w = \frac{4}{3} \text{ m s}^{-1}</math> </p>	<p>M1A1 A1 (3)</p> <p>M1A1 A1 (3) [6]</p>

**Notes for Question 1**

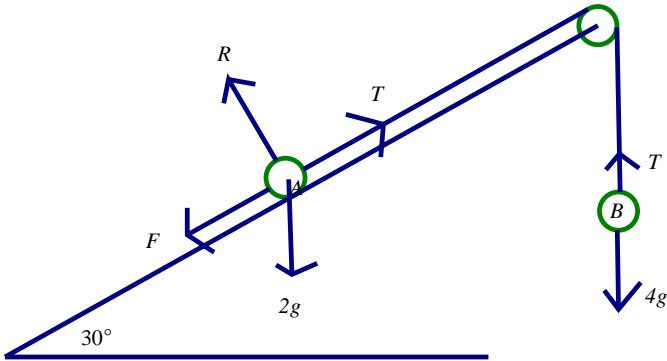
<p><b>Q1(a)</b></p>	<p>M1 for attempt at Impulse = difference in momenta <u>for particle A</u>, (must be considering <i>one</i> particle) (M0 if g is included or if mass omitted).            First A1 for <math>-14 = 2(\pm v - 5)</math>            Second A1 for 2 (Must be positive). Allow change of sign at end to obtain speed.</p>	
<p><b>Q1(b)</b></p>	<p><b>EITHER</b>            M1 for attempt at Impulse = difference in momenta <u>for particle B</u>, (must be considering <i>one</i> particle) (M0 if g is included or if mass omitted).            First A1 <math>14 = 3(\pm w - -6)</math>            Second A1 for 4/3, 1.3 or better (Must be positive). Allow change of sign at end to obtain speed.</p> <p><b>OR</b>            M1 for attempt at CLM equation, with correct no. of terms, dimensionally correct. Allow consistent extra g's and sign errors.            First A1 (<b>Not f.t.</b>) for a correct equation e.g.  <math>2 \times 5 - 3 \times 6 = -2 \times 2 + 3w</math>            Second A1 for speed is 4/3; 1.3 or better            N.B. They may find the speed of B first and then use CLM to find the speed of A.            It must be clear which speed is which, in order to gain the A marks for the answers</p>	

Question Number	Scheme	Marks
2.	 <p>Resolve horizontally: <math>T_A \cos 35^\circ = T_B \cos 25^\circ</math></p> <p>Resolve vertically: <math>T_A \sin 35^\circ + T_B \sin 25^\circ = 8</math></p> <p>Equation in one unknown: <math>T_B \frac{\cos 25^\circ}{\cos 35^\circ} \sin 35^\circ + T_B \sin 25^\circ = 8</math></p> <p style="text-align: center;">or <math>T_A \sin 35^\circ + T_A \frac{\cos 35^\circ}{\cos 25^\circ} \sin 25^\circ = 8</math></p> <p><math>T_A = 8.4, 8.37, 8.372</math> (N) or better</p> <p><math>T_B = 7.6, 7.57, 7.567</math> (N) or better</p> <p><b>2alt OR</b></p> <p>Using Sine Rule on triangle of forces: <math>\frac{8}{\sin 60^\circ} = \frac{T_A}{\sin 65^\circ} = \frac{T_B}{\sin 55^\circ}</math></p> <p><math>\frac{8 \times \sin 65^\circ}{\sin 60^\circ} = T_A, = 8.4, 8.37, 8.372</math> (N) or better</p> <p><math>\frac{8 \times \sin 55^\circ}{\sin 60^\circ} = T_B, = 7.6, 7.57, 7.567</math> (N) or better</p>	<p>M1A1</p> <p>M1A1</p> <p><b>DM1A1</b></p> <p>A1</p> <p>A1</p> <p style="text-align: right;"><b>(8)</b></p> <p>M1A1</p> <p>M1A1, A1</p> <p>M1A1, A1</p>

**Notes for Question 2**

<b>2</b>	<p>First M1 for resolving horizontally with correct no. of terms and both <math>T_A</math> and <math>T_B</math> terms resolved.            First A1 for a correct equation.            Second M1 for resolving vertically with correct no. of terms and both <math>T_A</math> and <math>T_B</math> terms resolved.            Second A1 for a correct equation.            Third M1, dependent on first two M marks, for eliminating <math>T_A</math> or <math>T_B</math>            Third A1 for a correct equation in one unknown            Fourth A1 for <math>T_A = 8.4</math> (N) or better.            Fifth A1 for <math>T_B = 7.6</math> (N) or better.            N.B. The first two M marks can be for two resolutions in any two directions.            N.B. If the two tensions are taken to be equal, can score max M1A0 for vertical resolution.</p>	
<b>2 alt 1</b>	See <b>Alternative 1</b> using a Triangle of Forces and the Sine Rule.	
<b>2 alt 2</b>	<p><b>Alternative 2</b> is to resolve perpendicular to each string:            The scheme is similar to Alt 1 and gives the same expressions for <math>T_A</math> and <math>T_B</math>            M1A1 resolving perp to <i>both</i> strings as a complete method.            M1A1A1 for finding <math>T_A</math>            M1A1A1 for finding <math>T_B</math></p>	



Question Number	Scheme	Marks
3.	 <p>Equation of motion of B: <math>4g - T = 4a</math></p> <p>Equation of motion of A: <math>T - F - 2g \sin 30 = 2a</math></p> <p>OR: <math>4g - F - 2g \sin 30 = 6a</math></p> <p>Resolve perpendicular to the plane at A: <math>R = 2g \cos 30</math></p> <p>Use of <math>F = \mu R</math> : <math>F = \frac{1}{\sqrt{3}} \times 2g \cos 30 (= g)</math></p> $T - g - g = T - 2g = 2a$ $2T - 4g = 4g - T, \quad 3T = 8g, \quad T = \frac{8g}{3} (\approx 26) \quad 26.1(\text{N})$	<p>M1A1</p> <p>M1A2</p> <p>B1</p> <p>M1</p> <p><b>DM1A1</b></p> <p style="text-align: right;"><b>(9)</b> <b>[9]</b></p>
<b>Notes for Question 3</b>		
3	<p>First M1 for resolving vertically (up or down) for B, with correct no. of terms.</p> <p>First A1 for a correct equation.</p> <p>Second M1 for resolving parallel to the plane (up or down) for A, with correct no. of terms.</p> <p>A2 for a correct equation (-1 each error)</p> <p><b>OR:</b> M2 A3 for the whole system equation - any method error loses all the marks.</p> <p>B1 for perpendicular resolution</p> <p>Third M1 for sub for R in <math>F = \mu R</math></p> <p>Fourth DM1, dependent on first and second M marks, for eliminating <math>a</math>.</p> <p>Fourth A1 for <math>8g/3</math>, 26.1 or 26 (N). (392/15 oe is A0)</p>	

Question Number	Scheme	Marks
<p><b>4.</b> <b>(a)</b></p> <p><b>(b)</b></p>	<p>Use of <math>s = ut + \frac{1}{2}at^2</math></p> <p><math>-2t + \frac{1}{2}gt^2</math> (+ or - 50)</p> <p><math>20t - \frac{1}{2}gt^2</math> (+ or - 50)</p> <p><math>50 = -2T + \frac{1}{2}gT^2 + 20T - \frac{1}{2}gT^2 = 18T</math></p> <p><math>T = \frac{50}{18} = 2.777\dots = 2.8</math> or better</p> <p><math>h = 20 \times T - 4.9 \times T^2 = 17.74\dots \approx 17.7</math> (18 to 2 s.f.) (use of 2.8 gives 17.584)</p>	<p>M1</p> <p>A1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>(5)</p> <p>M1A1</p> <p>(2)</p> <p>[7]</p>
<b>Notes on Question 4</b>		
<b>Q4(a)</b>	<p>First M1 for use of <math>s = ut + 1/2at^2</math> (or use of 2 <i>suvat</i> formulae AND eliminating <math>v</math>, to give an equation in <math>s</math> and <math>t</math>). N.B. M0 if they use <math>s = 50</math> or <math>u = 0</math> or <math>v = 0</math>)</p> <p>First A1 with <math>u = 2</math> and <math>a = -g</math> or <math>-9.8</math> to obtain a distance, possibly with 50 added or subtracted. (2 and 4.9 must have <i>opposite</i> signs)</p> <p>Second A1 with <math>u = 20</math> and <math>a = -g</math> or <math>-9.8</math> to obtain a distance, possibly with 50 added or subtracted. (2 and 4.9 must have <i>opposite</i> signs)</p> <p>Second M1 dependent on first M1 for a <i>correct</i> equation obtained correctly in <math>T</math> only.</p> <p>Third A1 for 25/9 oe, 2.8 or better</p>	
<b>Q4(b)</b>	<p>First M1 for substituting their <math>T</math> value (allow -ve changed to +ve but A mark is then unavailable) into an appropriate equation</p> <p>First A1 for 17.7 or 18 (m). (A0 if they then add 50)</p>	

Question Number	Scheme	Marks
<p><b>5.</b> <b>(a)</b></p>	$s = \frac{u+v}{2}t \quad 10 = \frac{2+v}{2} \times 3.5$ $v = \frac{20}{3.5} - 2 = \frac{26}{7} = 3.71 \text{ (m s}^{-1}\text{)}$	<p>M1A1 A1 <b>(3)</b></p>
<p><b>(b)</b></p>	$a = \frac{v-u}{t} = \frac{\frac{26}{7} - 2}{3.5} = \frac{24}{49} = 0.490 \text{ (m s}^{-2}\text{)}$	<p>M1A1 <b>(2)</b></p>
<p><b>(c)</b></p>	<p>Normal reaction : <math>R = 0.6g \cos 25^\circ</math>  Resolve parallel to the slope : <math>0.6g \sin 25^\circ - \mu \times R = 0.6 \times a</math>  <math>\mu = 0.41</math> or <math>0.411</math></p>	<p>B1 M1A2 A1 <b>(5)</b> <b>[10]</b></p>
<b>Notes for Question 5</b>		
<p><b>Q5(a)</b></p>	<p>First M1 for producing an equation in <math>v</math> <i>only</i>.  First A1 for a correct equation  Second A1 for <math>26/7</math> oe, <math>3.7</math> or better (<math>\text{ms}^{-1}</math>)</p>	
<p><b>Q5(b)</b></p>	<p>M1 for producing an equation in <math>a</math> <i>only</i>.  A1 for <math>24/49</math>, <math>0.49</math> or better (<math>\text{ms}^{-2}</math>)</p>	
<p><b>Q5(c)</b></p>	<p>B1 for <math>R = 0.6g \cos 25^\circ</math>  M1 for resolving along the plane, correct no. of terms etc.  A2 (-1 each error) <math>R</math> and <math>a</math> do not need to be substituted  Third A1 for <math>0.41</math> or <math>0.411</math></p>	

Question Number	Scheme	Marks
6. (a)	Use of $r = r_0 + vt$ $(-4i + 2j) + (3i + 3j)t = (-4 + 3t)i + (2 + 3t)j$	M1 A1 (2)
(b)	$(6i + j) + (-2i + nj)t = (6 - 2t)i + (1 + nt)j$ Position vectors identical $\Rightarrow -4 + 3t = 6 - 2t$ <b>AND</b> $5t = 10$ , Either equation $2 + 3 \times 2 = 1 + 2n$ , $n = 3.5$	B1 M1 A1 <b>DM1</b> A1 (5)
(c)	Position vector of P is $(-4 + 6)i + (2 + 6)j = 2i + 8j$ Distance OP = $\sqrt{2^2 + 8^2} = \sqrt{68} = 8.25$ (km)	M1A1 M1A1 (4) <b>[11]</b>

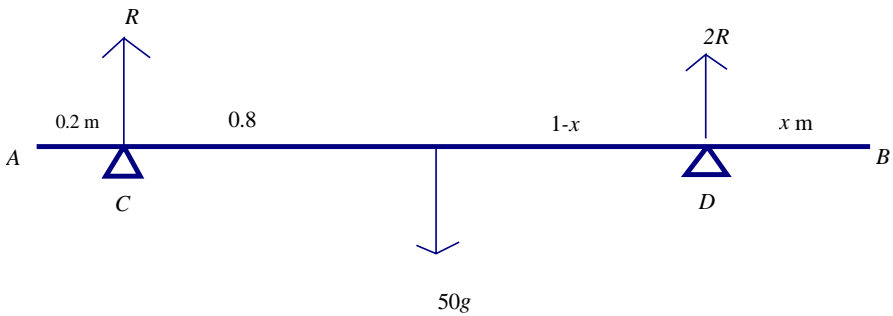
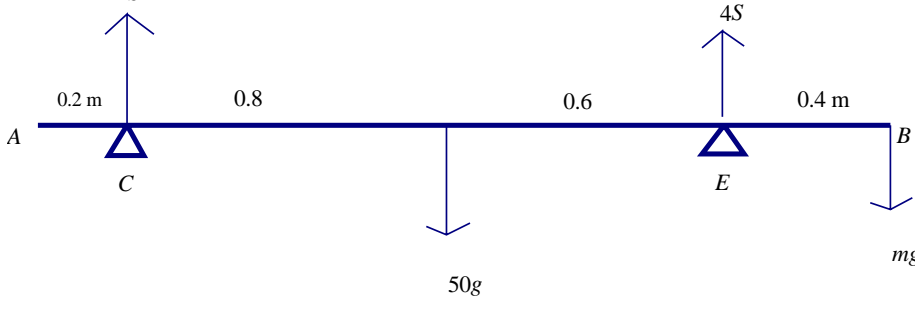
**Notes for Question 6**

<b>Q6(a)</b>	M1 for clear attempt to use $r_0 + tv$ (M0 if $r_0$ and $v$ reversed) A1 for answer in any form.	
<b>Q6(b)</b>	B1 for $(6i + j) + (-2i + nj)t$ seen or implied First M1 for equating their <b>i</b> - cpts <i>and</i> their <b>j</b> - cpts. (must have <i>both</i> equations in terms of <i>same t</i> ) First A1 for a correct equation (either) Second M1 dependent on first M1 for producing an equation in $n$ only. Second A1 for $n = 3.5$ oe	
<b>Q6(c)</b>	First M1 for clear attempt to find pv of $P$ , using their $t$ and/or $n$ value(s) First A1 for $2i + 8j$ Second M1 for attempt to find magnitude of their <b>p</b> Second A1 for $\sqrt{68}$ , $2\sqrt{17}$ , 8.2 or better (km)	

Question Number	Scheme	Marks
7 (a)	Use of $v^2 = u^2 + 2as$ $14^2 = 20^2 - 2a \times 100$ Deceleration is $1.02(\text{m s}^{-2})$	M1 A1 A1 (3)
(b)	Horizontal forces on the car: $\pm T \cos \theta - 300 = 750 \times -1.02 = -765$ $T = -1550/3$ The force in the tow-bar is $1550/3, 520$ (N) or better (allow -ve answer)	M1A2 f.t. A1 (4)
(c)	Horizontal forces on the truck: $\pm T \cos \theta - 500 - R = 1750 \times -1.02$ Braking force $R = 1750$ (N)	M1A2 f.t. A1 (4)
	<b>ALT:</b> Whole system: $800 + R = 2500 \times 1.02$ $R = 1750$	M1A2 f.t. A1 [11]

**Notes for Question 7**

Q7(a)	M1 for a complete method to produce an equation in $a$ only. First A1 for a correct equation. Second A1 for $1.02 (\text{ms}^{-2})$ oe. must be POSITIVE.	
Q7(b)	M1 for considering <u>the car ONLY</u> horizontally to produce an equation in $T$ only, with usual rules. i.e. correct no. of terms AND $T$ resolved: $\pm T \cos \theta - 300 = 750 \times -1.02$ A2 ft on their $a$ for a correct equation ( <u>300 and <math>a</math> must have same sign</u> ); -1 each error (treat $\cos 0.9$ as an A error) A1 for $1550/3$ oe, $520$ or better (N) N.B. <u>Allow a negative answer.</u>	
Q7(c)	M1 for considering <u>the truck ONLY</u> horizontally to produce an equation, with usual rules. i.e. correct no. of terms AND $T$ resolved: $\pm T \cos \theta - 500 - R = 1750 \times -1.02$ A2 ft on their $T$ and $a$ for a correct equation ( <u>500, <math>a</math> and <math>R</math> must have same sign</u> ); -1 each error (treat $\cos 0.9$ as an A error) A1 for $1750$ (N). <b>OR</b> M1 for considering <u>the whole system</u> to produce an equation in $R$ only, with usual rules. i.e. correct no. of terms. A2 ft on their $a$ for a correct equation ( <u><math>a</math> and <math>R</math> must have same sign</u> ) -1 each error A1 for $1750$ (N). N.B. If 300 and 500 are given separately, penalise any sign errors only ONCE.	

Question Number	Scheme	Marks
<p><b>8.</b> <b>(a)</b></p>	 <p>Vertical equilibrium: <math>R + 2R = 50g</math>,  Moments about C: <math>50g \times 0.8 = (1.8 - x) \times 2 \times R</math>  <math>3 \times 0.8 = 3.6 - 2x</math>, <math>x = 0.6</math></p>	<p>M1A1 M1A1 DM1A1 <b>(6)</b></p>
<p><b>(b)</b></p>	 <p><math>S, 4S</math>  Vertical equilibrium: <math>S + 4S = (50 + m)g = 5S</math>  Moments about B: <math>50g \times 1 = 4S \times 0.4 + S \times 1.8 = 3.4S</math>  <math>50 \times \frac{5}{3.4} = (50 + m)</math>  <math>m = 400/17, 24, 23.5</math> or better</p>	<p>B1 M1A1 M1A1 DM1 A1 <b>(7)</b> <b>[13]</b></p>

**Notes for Question 8**

<b>Q8(a)</b>	<p><b>In both parts consistent omission of g's can score all the marks.</b></p> <p>First M1 for vertical resolution or a moments equation, with usual rules. (allow <math>R</math> and <math>N</math> at this stage)</p> <p>First A1 for a correct equation (with <math>N = 2R</math> substituted)</p> <p>Second M1 for a moments equation in <math>R</math> and one unknown length with usual rules.</p> <p>Second A1 for a correct equation.</p> <p>Third M1, dependent on first and second M marks, for solving for <math>x</math></p> <p>Third A1 for <math>x = 0.6</math>.</p> <p>S.C. Moments about centre of rod: <math>R \times 0.8 = 2R(1 - x)</math> M2 A2</p>	
<b>Q8(b)</b>	<p>B1 for <math>S</math> and <math>4S</math> placed correctly.</p> <p>First M1 for vertical resolution or a moments equation, with usual rules. (allow <math>S</math> and <math>4S</math> reversed)</p> <p>First A1 for a correct equation.</p> <p>Second M1 for a moments equation in <math>S</math> (and <math>m</math>) with usual rules.</p> <p>Second A1 for a correct equation.</p> <p>Third M1, dependent on first and second M marks, for <i>eliminating</i> <math>S</math> to give an equation in <math>m</math> <i>only</i>.</p> <p>Third A1 for <math>m = 400/17</math> oe or 24 or better.</p> <p>N.B. SC If they use the reaction(s) found in part (a) in their equations, can score max B1M1A0M1A0DM0A0.</p>	

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