

Oxford Cambridge and RSA Examinations

**Advanced Subsidiary General Certificate of Education
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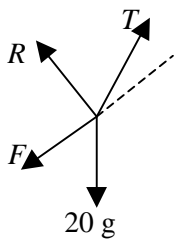
MEI STRUCTURED MATHEMATICS
MECHANICS 1, M1

4761

MARK SCHEME

Qu	Answer	Mark	Comment
Section A			
1(i)(A)		B1	All forces correctly labelled with arrows. Angle not required. Accept T_1, T_2, W etc. No extra forces
1(i)(B)	Resolve \leftarrow $T - 10 \cos 60 = 0$ $T = 5$ so 5N	M1 A1 [3]	Attempt at horiz resolution. No extra forces
1(ii)	Resolve \downarrow $mg = 10 \sin 60$ $m = 0.8836\dots$ so 0.884 (3 s.f.)	M1 A1 A1 [3]	Attempt at vertical resolution. No extra forces. Allow $m = 10 \sin 60$ and $m = 10 \cos 60$ Any reasonable accuracy
2(i)	$\sqrt{(-1)^2 + 4^2} = \sqrt{17} \text{ ms}^{-1}$	M1 A1 [2]	Use of Pythagoras
2(ii)	$\mathbf{v} = \begin{pmatrix} -1 \\ 4 \end{pmatrix} + 4 \begin{pmatrix} 2 \\ 5 \end{pmatrix} = \begin{pmatrix} 7 \\ 24 \end{pmatrix} \text{ ms}^{-1}$ $\mathbf{s} = \begin{pmatrix} 2 \\ -1 \end{pmatrix} + 4 \begin{pmatrix} -1 \\ 4 \end{pmatrix} + 8 \begin{pmatrix} 2 \\ 5 \end{pmatrix} = \begin{pmatrix} 14 \\ 55 \end{pmatrix} \text{ m}$	M1,A1 M1 A1 [4]	Must attempt all terms [If integration used M1 for integration attempted plus attempt at initial condition]
3(i)	N2L \rightarrow $T - 8 = 5 \times 4$ $T = 28$ so 28 N	M1 A1 A1 [3]	Use of N2L. Accept mga . All forces present. No extras Accept sign errors LHS
3(ii)	N2L \rightarrow $40 \cos 30 - 8 = 5a$ $a = 5.3287\dots$ so 5.33 ms^{-2} (3 s.f.)	M1 B1 A1 [3]	N2L. Must be ma . All terms present. No extras 40 cos 30

Qu	Answer	Mark	Comment
Section A (continued)			
4(i)		B1 [1]	Accept any form for weight. Arrows required. Accn not required. Accept different tensions only if shown equal later. Accept single equivalent diagram. No spurious forces
4(ii)(A)	<p>For A, using N2L</p> $8 \times 9.8 - T = 8a$ <p>For B, using N2L</p> $T - 6 \times 9.8 = 8a$	M1 A1 A1	N2L. Allow ' $F = mga$ ' and sign errors; condone one force missing. LHS correct. Accept $T - 8 \times 9.8$ Must be consistent with equation for A Signs consistent, all forces present and ' $F = ma$ ' used. Elimination of T or a .
4(ii)(B)	Solve $a = 1.4$ so 1.4 ms^{-1}	M1 E1 [5]	
5(i)	$\mathbf{a} = (2t - 1)\mathbf{i} + \mathbf{j}$ $\mathbf{a}(2) = 3\mathbf{i} + \mathbf{j}$	M1 A1 [2]	Differentiation
5(ii)(A)	<p>\mathbf{i} component of \mathbf{v} zero when $t^2 - t = 0$</p> <p>so $t = 0$ or $t = 1$</p> <p>\mathbf{j} cpt zero when $t = 1$</p> <p>At rest when both cpts zero so $t = 1$</p>	M1 A1 A1	Finding when either cpt of \mathbf{v} is zero. Do not accept \mathbf{a} or \mathbf{s} . All three times correct ft their values
5(ii)(B)	Travelling south when \mathbf{i} cpt zero so $t = 0$	A1 [4]	ft their values

Qu	Answer	Mark	Comment
Section A (continued)			
6(i)		B1 [1]	All forces present. No extras. All labelled and with arrows. F up or down plane. No angles required. Accept $W, mg, 196\text{ N}$
6(ii)	$172 \cos 25 = 20g \sin 40 + F$ $F = 29.89 \dots \text{ so } 29.9\text{ N (3 s.f.)}$	M1 B1 A1 [3]	Resolving parallel to the plane. All forces present. At least one force resolved. Accept $\pm F$ Weight term Accept negative only if consistent with the diagram
6(iii)	<p>We need $T \cos 25 < 20g \sin 40$ So $T < 139.01\dots$ so 139 N (3 s.f.)</p>	M1 A1 [2]	
			Section A Total: 36

Qu	Answer	Mark	Comment
Section B			
7(i)	t 0 10 15 20 v 0 20 20 24	B1 B1 B1 [3]	$t = 0$ $t = 10$ $t = 20$ and $t = 15$ (FT on their $t = 10$)
7(ii)(A)	$a = 4 - 0.4t$ so $4 - 0.4 \times 7 = 1.2 \text{ ms}^{-2}$	M1 A1	Differentiating with one term correct
7(ii)(B)	0 ms^{-2}	B1	
7(ii)(C)	0.8 ms^{-2}	B1 [4]	
7(iii)	$10 \leq t \leq 15$ $5 \times 20 = 100 \text{ m}$ $15 \leq t \leq 20$ $20 \times 5 + 0.5 \times 0.8 \times 25$ = 110 m Total is 210 m	M1 B1 M1 A1 A1 A1 [6]	Recognise need to split into 2 sections ‘ <i>uvast</i> ’ or integrate from $t = 15$ to $t = 20$ Correct subst into <i>uvast</i> or correct integration (neglect limits). If <i>uvast</i> ft only $v(15)$, $v(20)$ from part (i) and $a(16)$ from part (ii)(C) cao ft dep on both B1 and M1 awarded [If single rule applied from $t = 10$ to 20: Using <i>uvast</i> . FT u , v and $a \neq 0$. Allow sign errors. SC1 If integration of $v = 8 + 0.8t$ attempted and integration correct SC1]

Qu	Answer	Mark	Comment
Section B (continued)			
7(iv)	$\int_0^{10} (4t - 0.2t^2) dt$ $= \left[2t^2 - \frac{2}{30}t^3 \right]_0^{10}$ $= 200 - \frac{2000}{30}$ $= 133\frac{1}{3} \text{ m or } 133 \text{ m (3 s.f.)}$	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>B1</p> <p>[5]</p>	<p>Integration; must see evidence. Neglect limits. M0 for use of const accn</p> <p>At least one term correct. Neglect limits</p> <p>Dependent on 1st M1. Subst correct limits in definite integral or correct subst for arb constant. Need \int_0^{10} or $[]_0^{10}$ or evidence of $t=0$ substituted</p> <p>Correct limits or arb constant</p> <p>At least 3 s.f. accuracy. Award if seen</p> <p>[SC M1 for correct attempt at numerical integration (i.e. find area under curve)</p> <p>M1 for attempt at trapezia with strips ≤ 1 s</p> <p>A2 only if accurate to 3 s.f.]</p>

Qu	Answer	Mark	Comment
Section B (continued)			
8(i)(A)	Distance dropped is $0 + .5 \times 9.8t^2$ so $y = 78.4 - 4.9t^2$	M1,A1 E1	Must have ± 9.8 or ± 10 and initial speed zero Must be fully shown
8(i)(B)	$x = 14t$	B1 [4]	Allow if seen later
8(ii)(A)	$y = 0$ gives $4.9t^2 = 78.4$ so $t^2 = 16$ and $t = 4$	M1 A1	Setting $y = 0$ Only positive t need be considered
8(ii)(B)	$x = 14 \times 4 = 56$ so 56 m	M1 A1 [4]	ft t only
8(iii)	$y = 78.4 - 4.9 \times \left(\frac{x}{14}\right)^2$ giving $40y = 3136 - x^2$	M1 E1 [2]	Substitute in correct expression to eliminate t Fully shown
8(iv)	1 st stone takes $\frac{35}{14} = 2.5$ s to reach $x = 35$ 2 nd stone is at y s.t. $40y = 3136 - 35^2$ so $y = 47.775$	M1 E1 M1 E1 [4]	Use of this equation or equivalent method
8(v)	2 nd stone is 47.775 m high after 2.5 s so $47.775 = 2.5u - 4.9 \times 2.5^2$ and $u = 31.36$ so 31.4 ms^{-1} (3 s.f.) (31.45... if $s = 48$ used)	M1 B1 A1 A1 [4]	An appropriate choice of $uvast(s)$ for the motion of the 2 nd stone $s = 47.775$ or 48 and $t = 2.5$ used Condone $s = 48$ cao
			Section B Total: 36
			Total: 72

AO	Range	Total	Question Number							
			1	2	3	4	5	6	7	8
1	14-22	22	1	-	2	3	1	1	8	6
2	14-22	16	1	3	1	1	1	1	4	4
3	18-26	20	2	3	2	1	1	2	4	5
4	7-15	9	1	-	-	1	3	2	1	1
5	3-11	5	1	-	1	-	-	-	1	2
Totals		72	6	6	6	6	6	6	18	18