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Mark Scheme (Results)

October 2025

Pearson Edexcel International Advanced Level in Mechanics M2

WME02/01A

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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.
- 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.

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EDEXCEL IAL 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 $\surd$ 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)
- d… or dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- * The answer is printed on the paper or ag- answer given
- $\lfloor$ or d… The second mark is dependent on gaining the first mark

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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. If you are using the annotation facility on ePEN, indicate this action by 'MR' in the body of the script.

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.

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General Principles for Mechanics Marking

(***N.B.*** *specific mark schemes may sometimes override these general principles)*

- Rules for M marks:
  - correct number of terms
  - dimensionally correct
  - all terms that need resolving (i.e. *multiplied* by cos or sin) are resolved
  - only terms that need resolving are resolved
  - +/– errors are condoned
  - sin/cos confusion is condoned
- Omission or extra *g* in a resolution is an accuracy error not method error.
- Omission of mass from a resolution is a 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(s) has been awarded.
- Any numerical answer which comes from use of $g = 9.8$ should be given as a decimal 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.

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- 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

Mechanics Abbreviations

M(A)	Taking moments about A
N2L	Newton's Second Law (Equation of Motion)
NEL	Newton's Experimental Law (Newton's Law of Impact)
HL	Hooke's Law
SHM	Simple harmonic motion
PCLM	Principle of conservation of linear momentum
RHS	Right hand side
LHS	Left hand side

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Question Number	Scheme	Marks
1	Impulse-momentum equation	M1
	$(7\mathbf{i}-5\mathbf{j})=4\mathbf{v}-4(2\mathbf{i}+3\mathbf{j})$	A1
	$\mathbf{v}=\frac{15}{4}\mathbf{i}+\frac{7}{4}\mathbf{j}$	A1
	$\lvert\mathbf{v}\rvert=\frac{1}{4}\sqrt{15^2+7^2}$	M1
	$=\frac{1}{4}\sqrt{274}=4.1\ (\text{m s}^{-1})$	A1
		(5)
		(5 marks)

Notes	
N.B. Column vectors are acceptable throughout	
M1	Use of Impulse-Momentum principle, dimensionally correct, correct number of terms and must be a *difference* of momenta (condone subtraction in wrong order)
A1	Correct equation oe
A1	Correct velocity seen or implied
M1	Use of Pythagoras' on their **v**
A1	Cao from a correct **v**. 4.1 or better (4.138236…)

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Question Number	Scheme	Marks
2(a)	Moments about x-axis	M1
	$m\times 2+4m\times 3-km\times 4=0$	A1
	$k=3.5$	A1
		(3)
2(b)	Moments about y-axis $m\times -3+4m\times 4+km\times 6=(5+k)m\times c$	M1
	$m\times -3+4m\times 4+3.5m\times 6=8.5m\times c$	A1ft
	$c=4$	A1
		(3)
		(6 marks)

Notes	
(a) M1	All terms needed and no extras. Must be dimensionally consistent (allow with g in each term or consistent missing m). Condone sign errors.
A1	Correct unsimplified equation. Allow in vector form.
A1	oe
(b) M1	All terms needed and no extras (k does not need to be substituted). Must be dimensionally consistent (allow with g in each term or consistent missing m). Condone sign errors. Award if seen in part (a).
A1ft	Correct unsimplified equation with their value of k substituted. Award if seen in part (a). Allow in vector form.
A1	cao

Question Number	Scheme	Marks

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3(a)	Differentiate **r** w.r.t. t	M1
	$\left(\mathbf{v}=\frac{\mathrm{d}\mathbf{r}}{\mathrm{d}t}=\right)\quad\left(16-9t^2\right)\mathbf{i}+\left(3t^2-2t\right)\mathbf{j}$	A1
	Sets **i** component = 0: $16-9t^2=0$	M1
	$t=\frac{4}{3}\Rightarrow\mathbf{v}=\ldots$	dM1
	$\mathbf{v}=\left(3\times\frac{16}{9}-2\times\frac{4}{3}\right)\mathbf{j}=\frac{8}{3}\mathbf{j}$	A1
		(5)
3(b)	Differentiate **v** w.r.t. t	M1
	$\left(\mathbf{a}=\frac{\mathrm{d}\mathbf{v}}{\mathrm{d}t}=\right)\quad\left(-18t\right)\mathbf{i}+\left(6t-2\right)\mathbf{j}$	A1ft
	Substitutes $t = 4$ and finds magnitude	dM1
	$\lvert\mathbf{a}\rvert=\sqrt{72^2+22^2}=\sqrt{5668}=75$ (m s^{-2})	A1
		(4)
		(9 marks)

Notes (*N.B. Column vectors are acceptable throughout)*

(a) M1	Differentiates **r** w.r.t. t: at least one power decreasing by one in both **i** and **j** components.
A1	Correct vector
M1	Sets their **i** component equal to zero.
dM1	Solves for t **and** substitutes to find a velocity (or speed). Dependent on both previous M marks.
A1	Cao. Penalise extra solutions unless clearly discounted. Must be a vector. ISW if they go on to find a speed.
(b) M1	Differentiates **v** w.r.t. t: at least one power decreasing by one in both **i** and **j** components.
A1	Follow their **v** providing both **i** and **j** components are non-zero.
DM1	Substitutes $t = 4$ into their acceleration **and** uses Pythagoras' to find a magnitude. Dependent on previous M mark
A1	Cao. 75 or better (75.28612…) from correct working.

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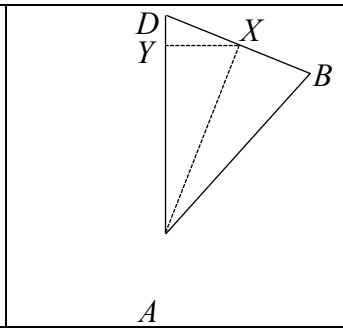
<table>
<tr><th>Question Number</th><th>Scheme</th><th>Marks</th></tr>
<tr><td rowspan="4">4(a)</td><td>Vertical distance from A to C is $a+a\cos\theta$</td><td>B1</td></tr>
<tr><td>“Half the vertical height of the diagram”
Using the symmetry of the figure, the centres of mass of the rhombuses lie on a straight line passing through the centre of mass.</td><td>M1</td></tr>
<tr><td>$0.9a=\frac{1}{2}\left(a+a\cos\theta\right)$</td><td>A1
A1</td></tr>
<tr><td>$\cos\theta=0.8$ *</td><td>A1*</td></tr>
<tr><td></td><td>(5)</td></tr>
<tr><td rowspan="4">Alt1</td><td>Distance from A to centre of rhombus = $a\cos\frac{\theta}{2}$</td><td>B1</td></tr>
<tr><td>“Moments using CoM of two rhombuses”
Taking moments about an axis through A parallel to FB</td><td>M1</td></tr>
<tr><td>$\lambda.a\cos\frac{\theta}{2}.\cos\frac{\theta}{2}+\lambda.a\cos\frac{\theta}{2}\cos\frac{\theta}{2}=2\lambda\times0.9a$</td><td>A1
A1</td></tr>
<tr><td>$\cos\theta=2\cos^2\frac{\theta}{2}-1=0.8$ *
</td><td>A1*</td></tr>
<tr><td></td><td></td><td>(5)</td></tr>
<tr><td rowspan="5">Alt2</td><td colspan="2">Distance from A to centre of rhombus (= AX =) $a\cos\frac{\theta}{2}$</td><td>B1</td></tr>
<tr><td>“Vertical height of CoM rhombus”
Using the symmetry of the figure, the centres of mass of the rhombuses lie on a straight line passing through the centre of mass:
$AY=AX\cos\frac{\theta}{2}$</td><td></td><td>M1</td></tr>
<tr><td colspan="2">$a\cos\frac{\theta}{2}\times\cos\frac{\theta}{2}=0.9a$</td><td>A1
A1</td></tr>
<tr><td colspan="2">$\cos\theta=2\cos^2\frac{\theta}{2}-1=0.8$ *
</td><td>A1*</td></tr>
<tr><td colspan="2"></td><td>(5)</td></tr>
<tr><td>Alt3</td><td colspan="2"><table>
<tr><td>Shape</td><td>EFBC</td><td>EDC</td><td>FAB</td><td>lamina</td></tr>
<tr><td>Mass/Area</td><td>$2a^2\sin\theta$</td><td>$a^2\sin\theta\cos\theta$</td><td>$a^2\sin\theta\cos\theta$</td><td>$2a^2\sin\theta$</td></tr>
<tr><td>CoM</td><td>$a\cos\theta+\frac{a}{2}$</td><td>$a+\frac{2}{3}a\cos\theta$</td><td>$\frac{2}{3}a\cos\theta$</td><td>$0.9a$</td></tr>
</table></td><td>B1</td></tr>
<tr><td colspan="2">Moments equation (“Rectangle minus triangle plus triangle”)</td><td>M1</td></tr>
</table>

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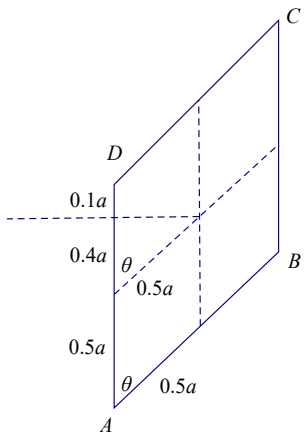
<table>
<tr><td></td><td>$2a^2\sin\theta\left(a\cos\theta+\frac{a}{2}\right)-a^2\sin\theta\cos\theta\left(\frac{2}{3}a\cos\theta+a-\frac{2}{3}a\cos\theta\right)=2a^2\sin\theta\times0.9a$</td><td>A1
A1</td></tr>
<tr><td></td><td>$\cos\theta=0.8$ *</td><td>A1*</td></tr>
<tr><td></td><td></td><td>(5)</td></tr>
<tr><td>Alt4</td><td><table>
<tr><td>Shape</td><td>EDF & BCD</td><td>AFD & ADB</td><td>lamina</td></tr>
<tr><td>Mass/Area</td><td>$2\times\frac{1}{2}a^2\sin\theta$</td><td>$2\times\frac{1}{2}a^2\sin\theta$</td><td>$2a^2\sin\theta$</td></tr>
<tr><td>CoM</td><td>$\frac{2}{3}a(1+\cos\theta)$</td><td>$\frac{1}{3}a(1+\cos\theta)$</td><td>$0.9a$</td></tr>
</table></td><td>B1</td></tr>
<tr><td></td><td>Moments equation (“two upper triangles and two lower triangles”)</td><td>M1</td></tr>
<tr><td></td><td>$2\times\frac{1}{3}a(1+\cos\theta)\times\frac{1}{2}a^2\sin\theta+2\times\frac{2}{3}a(1+\cos\theta)\times\frac{1}{2}a^2\sin\theta=2a^2\sin\theta\times0.9a$</td><td>A1
A1</td></tr>
<tr><td></td><td>$\cos\theta=0.8$ *</td><td>A1*</td></tr>
<tr><td></td><td></td><td>(5)</td></tr>
<tr><td>Alt5</td><td>$AM=a\cos\theta$ (where M is the midpoint of BF)</td><td>B1</td></tr>
<tr><td></td><td>“Midpoint of midpoints”
CoM lies at midpoint of DM</td><td>M1</td></tr>
<tr><td></td><td>$0.9a=a\cos\theta+\frac{1}{2}(a-a\cos\theta)$</td><td>A1
A1</td></tr>
<tr><td></td><td>$\cos\theta=0.8$ *</td><td>A1*</td></tr>
<tr><td></td><td></td><td>(5)</td></tr>
<tr><td>Alt6</td><td>“Working out the heights and trigonometry”

</td><td></td></tr>
<tr><td></td><td>0.4a seen or implied</td><td>B1</td></tr>
<tr><td></td><td>Use of line of centres of rhombuses and trigonometry</td><td>M1</td></tr>
<tr><td></td><td>$\cos\theta=\frac{0.4a}{0.5a}$</td><td>A1
A1</td></tr>
<tr><td></td><td>$\cos\theta=0.8$ *</td><td>A1*</td></tr>
<tr><td></td><td></td><td>(5)</td></tr>
</table>

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4(b)	Taking moments about *B*:	M1
	$kW(a\cos\theta)=W(0.9a-a\cos\theta)$	A1 A1
	$k=\frac{1}{8}$	A1
		(4)
Alt	Taking moments about *A*:	M1
	$0.9aW=(k+1)W\times a\cos\theta=(k+1)\times 0.8aW$	A1 A1
	$k=\frac{1}{8}$	A1
		(4)
		(9 marks)

Notes	
N.B. Be aware that candidates may have worked on a diagram on the question paper and may use their own labelling.	
(a) B1	$a+a\cos\theta$ seen
M1	Use of the symmetry of the figure for the height. Condone sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1*	Obtains given answer from correct exact working.
Alt1 B1	May be marked on a diagram
M1	Taking moments about an axis through *A* parallel to *FB*. Correct number of terms and dimensionally consistent. Condone sin/cos confusion. Any correct ratios in place of λ; may frequently see $a^2\sin\theta$.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation. $\left(\cos^2\frac{\theta}{2}=0.9\right)$
A1*	Obtains given answer from correct exact working.
Alt2 B1	May be marked on a diagram
M1	Use of the symmetry of the figure for the height. Condone sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation. $\left(\cos^2\frac{\theta}{2}=0.9\right)$
A1*	Obtains given answer from correct exact working.
Alt3 B1	Correct division of lamina with correct mass ratios Penalise errors in distance via the moments equation
M1	Moments equation about axis parallel to *FB*. Correct number of terms and dimensionally consistent. Condone sin/cos confusion.

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A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1*	Obtains given answer from correct exact working.
Alt4 B1	Correct division of lamina with correct mass ratios Penalise errors in distance via the moments equation
M1	Moments equation about axis parallel to *FB*. Correct number of terms and dimensionally consistent. Condone sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1*	Obtains given answer from correct exact working.
Alt5 B1	May be marked on a diagram
M1	Use of the symmetry of the figure for the height. Condone sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1*	Obtains given answer from correct exact working.
Alt6 B1	May be on a diagram (seen or implied). Could be implied by use of 0.1*a*.
M1	Use of the symmetry of the figure: the CoM lies on a line joining the centres of the rhombuses. Condone sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1*	Obtains given answer from correct exact working.
(b) M1	Moments about *B*. Must have both terms but condone sign errors and sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation. (0.8*kW* = 0.1*W*)
A1	Cao
Alt M1	Moments about *A* and use of CoM on *FB*. Must have correct number of terms but condone sign errors and sin/cos confusion.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1	Cao
N.B.	If a candidate does not specify the point about which they are taking moments, do not condone a "mixed approach". E.g. "$kW\left(a\cos\theta\right)=0.9aW$" is M0

Question Number	Scheme	Marks

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5(a)	Moments about *A*:	M1
	$6g(\times 1)\times \sin 70° = T\sin 30°\times 2$	A1 A1
	T = 55 or 55.3 (N)	A1
		(4)
5(b)	Resolve horizontally: $T\cos 50° = R(=35.5)$	B1
	Resolve vertically:	M1
	$T\sin 50° = 6g \pm F$	A1
	Use of $F = \mu R$ $\quad (6g - T\sin 50° = \mu \times T\cos 50°)$	M1
	μ = 0.46	A1
		(5)
5(c)	$\tan\theta = \frac{"R"}{"F"}$	M1
	(θ =) 65° to the upward vertical oe (25° above the horizontal)	A1
		(2)
		(11 marks)

Notes	
(a) M1	A complete method to find *T*. Moments equations must have the correct number of terms and be dimensionally consistent (missing *g* is an A error). Condone sin/cos confusion and sign errors; allow incorrect angles.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1	2 or 3 sf only
(b) B1	Resolve horizontally. T does not need to be substituted but ft their value from (a).
M1	Resolve vertically: condone sign errors and sin/cos confusion but must use 40° or 50°
A1	Correct equation/ T does not need to be substituted but ft their value from (a).
M1	Use of $F = \mu R$. Must have found a value for *F* and *R*.
A1	0.46 or better (0.4638131241…)
Alt	**N.B.** For the first three marks if other methods attempted, e.g. resolve parallel and perpendicular to rod or take moments about B or C: B1 for first correct equation seen M1A1 for the "best" second equation seen N.B. M(B) $\quad 6g(\times 1)\times \sin 70° = R\times 2\times \cos 70° \pm F\times 2\times \sin 70°$
(c) M1	Correct use of trigonometry (E.g. $\tan\theta = \frac{R}{F}$ or $\frac{F}{R}$) with their numerical values (seen or implied).
A1	Correct angle and direction indicated (allow clear angle on a clear diagram) 65° or better (65.11751087…) or 25° or better (24.88248913…)

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Question Number	Scheme	Marks
6(a)	Integrate *a* w.r.t. *t*	M1
	$(v=)\ t^2-3t\ \ (+c)$	A1
	Substitute to evaluate c: $t=3,\ v=2\ \Rightarrow c=2$	M1
	$v=t^2-3t+2$	A1
		(4)
6(b)	$v = 0 = t^2 - 3t + 2$ $(= (t-1)(t-2))$ $\Rightarrow t = \ldots$	M1
	$t = 1, 2$	A1
	$s=\int_1^2\left(t^2-3t+2\right)\mathrm{d}t$	M1
	$=\left[\frac{1}{3}t^3-\frac{3}{2}t^2+2t\right]_1^2$	A1ft
	$=\left[\frac{1}{3}(2)^3-\frac{3}{2}(2)^2+2(2)\right]-\left[\frac{1}{3}-\frac{3}{2}+2\right]$	dM1
	$\text{Distance}\ =\frac{1}{6}\ \text{(m)}$	A1
		(6)
		(10 marks)

Notes	
(a) M1	Integrate the given expression for *a*. Must see both powers increase by 1.
A1	Correct expression. Condone missing +c.
M1	Use of given values to find c (or definite integral with values substituted)
A1	Cao including "*v* ="
(b) M1	Set their *v* = 0 and solve for *t* to get two values.
A1	Cao
M1	Integrate their *v* (must have at least two terms). At least two powers increasing by 1.
A1ft	Condone without limits. Ft their *v* (at least two terms).
dM1	A correct method for the required distance, E.g. use of their values of *t* as limits. Dependent on previous M. Must see evidence of substitution: E.g. at least $\frac{2}{3}-\frac{5}{6}$ M0 for incorrect sums, E.g. $\int_0^1 \mathrm{d}t+\int_1^2 \mathrm{d}t$
A1	0.17 or better (do not accept e.g. 0.166). Must be positive.

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Question Number	Scheme			Marks
7(a)	Conservation of Energy:			M1
	$\frac{1}{2}m\times 12^2 = \frac{1}{2}m\times 8^2 + mgh$			A1 A1
	(h =) 4.1 (m)			A1
				(4)
7(b)	Vertical distance:			M1
	$"4.1" = 12\sin\alpha\times 1.5 - \frac{g}{2}\times 1.5^2$			A1ft
	$\alpha = 57°$			A1
				(3)
7(c)	Equation in α and β only			M1
	Eg. Horizontally: $12\cos\alpha = 8\cos\beta$	Eg. Vertical and horizontal components: $\tan\beta = \frac{12\sin\alpha - 1.5g}{12\cos\alpha}\left(=-0.709....\right)$		A1ft
	$\beta = 35°$			A1
				(3)
7(d)	Max height, T	Times when v = 8	Times when h = 4.08	M1
	$2(1.5 - T)$	$T_2 - T_1$	$T_2 - T_1$	dM1
	$T = \frac{12\sin\alpha}{g}$	$0 = 8\sin\beta\, T - \frac{1}{2}gT^2$	$4.08 = 12\sin\alpha\, T - \frac{1}{2}gT^2$	A1ft
	0.94 (s)			A1
				(4)
				(14 marks)

Notes	
(a) M1	Energy equation with correct number of terms and dimensionally correct including mass. M0 if no energy equation used or for incorrect energy formulae.
A1	Unsimplified equation with at most one error.
A1	Correct unsimplified equation.
A1	4.1 or 4.08 only (2 or 3sf)
(b) M1	Complete method to find an equation in sin α only, using their h. This equation could be obtained by getting two equations in α and β, which don't require h, and eliminating β
A1ft	Correct equation, ft their h if used. ($\sin\alpha = 0.839$)
A1	57° or 57.1° (or 1.0 or 0.996 radians) [57.06178257…]
(c) M1	A method to reach an equation in α and β only. E.g. Equating horizontal speed in terms of α and β or finding the vertical velocity components at B, v_V, and then using $\tan\beta = \frac{\lvert v_V\rvert}{12\cos\alpha}$ or $\sin\beta = \frac{\lvert v_V\rvert}{8}$.
A1ft	A correct equation in α (need not be substituted) and β, ft their h and α
A1	35° or 35.4° (or 0.617 or 0.62 radians) [35.35311389…]

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N.B.	v_V can be found in a number of ways [v_V = 4.628911565…] $v = u + at$: $v_V = 12\sin\alpha - 1.5g$ $v^2 = u^2 + 2as$: $v_V = \sqrt{(12\sin\alpha)^2 - 2g \times \text{their } h}$ $s = vt - \frac{1}{2}at^2$: $h = 1.5v_V + \frac{1}{2}g \times 1.5^2 \Rightarrow v_V = \frac{h - \frac{1}{2}g \times 1.5^2}{1.5} = \frac{2h}{3} - \frac{3g}{4}$ $s = \left(\frac{u+v}{2}\right)t$: $h = \left(\frac{12\sin\alpha + v_V}{2}\right) \times 1.5 \Rightarrow v_V = \frac{4}{h} - 12\sin\alpha$
(d) M1	Method to find an appropriate time(s), *T*, that could be used to find the required time: E.g.time to maximum height, times to height 4.08, times to speed being 8. M0 for total flight time unless they go on to use appropriately.
dM1	A correct overall method to use their *T* to find the required time.
A1ft	Correct equation for their *T*, ft their *h*, α, β
A1	0.94 or 0.945 obtained from correct working. [0.9446758295…]

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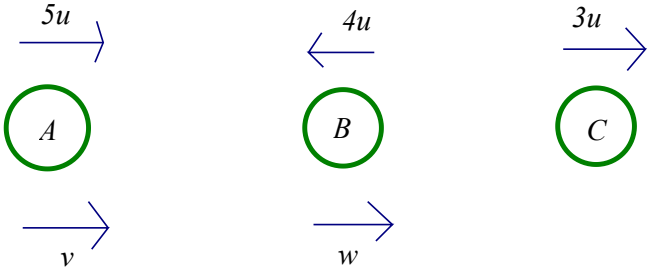
Question Number	Scheme	Marks
8(a)		
	CLM:	M1
	$5mu-4mu=mv+mw \qquad (u=v+w)$	A1
	NEL:	M1
	$w-v=9ue$	A1
	Solve for v or w	DM1
	$w=\frac{u}{2}(9e+1)$	A1
	$v=\left\|\frac{u}{2}(1-9e)\right\|$	A1
		(7)
8(b)	Use of $v < 0$ to find inequality involving e	M1
	$\frac{1}{9}<e$	A1
	Use of $w \leqslant 3u$	M1
	$\frac{1}{9}<e\leq\frac{5}{9}$	A1
		(4)

Notes	
(a) M1	Conservation of linear momentum. Needs all terms and dimensionally consistent but condone sign errors.
A1	Correct equation (m may be cancelled)
M1	Impact law. Condone sign errors but must not be reciprocal.
A1	Correct equation with directions consistent with momentum equation. **N.B.** Mark the equations even if inconsistent with any directions on their diagram
ddM1	Solve for v or w dependent on both previous M marks.
A1	Correct expression for speed of B after collision.
A1	Correct expression for speed of A; must include modulus as demand specifies speed.
(b) M1	Inequality considering direction of A reversed (i.e. their $v < 0$)
A1	Correct lower inequality. Must be strict inequality.
M1	Second inequality requiring speed of B to be less than or equal to the speed of C but condone strict inequality ($w < 3u$)
A1	cao