CAMBRIDGE
International Education

Cambridge International AS & A Level

MATHEMATICS **9709/42**

Paper 4 Mechanics **May/June 2025**

MARK SCHEME

Maximum Mark: 50

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Due to a series-specific issue during the live exam series, all candidates were awarded full marks for question 4 and 5. The mark scheme for these questions was not used by examiners.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:
Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:
Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:
Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:
Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:
Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:
Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Mathematics-Specific Marking Principles

1 Unless a particular method has been specified in the question, full marks may be awarded for any correct method. However, if a calculation is required then no marks will be awarded for a scale drawing.

2 Unless specified in the question, non-integer answers may be given as fractions, decimals or in standard form. Ignore superfluous zeros, provided that the degree of accuracy is not affected.

3 Allow alternative conventions for notation if used consistently throughout the paper, e.g. commas being used as decimal points.

4 Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored (isw).

5 Where a candidate has misread a number or sign in the question and used that value consistently throughout, provided that number does not alter the difficulty or the method required, award all marks earned and deduct just 1 A or B mark for the misread.

6 Recovery within working is allowed, e.g. a notation error in the working where the following line of working makes the candidate's intent clear.

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Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	More information required
	Accuracy mark awarded zero
	Accuracy mark awarded one
	Independent accuracy mark awarded zero
	Independent accuracy mark awarded one
	Independent accuracy mark awarded two
	Benefit of the doubt
	Blank Page
	Incorrect
Dep	Used to indicate DM0 or DM1

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Annotation	Meaning
DM1	Dependent on the previous M1 mark(s)
FT	Follow through
~~	Indicate working that is right or wrong
Highlighter	Highlight a key point in the working
ISW	Ignore subsequent work
J	Judgement
JU	Judgement
M0	Method mark awarded zero
M1	Method mark awarded one
M2	Method mark awarded two
MR	Misread
O	Omission or Other solution
Off-page comment	Allows comments to be entered at the bottom of the RM marking window and then displayed when the associated question item is navigated to.
On-page comment	Allows comments to be entered in speech bubbles on the candidate response.
PE	Judgment made by the PE
Pre	Premature approximation
SC	Special case
SEEN	Indicates that work/page has been seen

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Annotation	Meaning
SF	Error in number of significant figures
✓	Correct
TE	Transcription error
XP	Correct answer from incorrect working

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Mark Scheme Notes

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

M Method mark, awarded for a valid method applied to the problem. Method marks are not lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated method mark is earned (or implied).

B Mark for a correct result or statement independent of method marks.

DM or **DB** When a part of a question has two or more 'method' steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly, when there are several B marks allocated. The notation DM or DB is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.

FT Implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only.

- A or B marks are given for correct work only (not for results obtained from incorrect working) unless follow through is allowed (see abbreviation FT above).
- For a numerical answer, allow the A or B mark if the answer is correct to 3 significant figures or would be correct to 3 significant figures if rounded (1 decimal place for angles in degrees).
- The total number of marks available for each question is shown at the bottom of the Marks column.
- Wrong or missing units in an answer should not result in loss of marks unless the guidance indicates otherwise.
- Square brackets [ ] around text or numbers show extra information not needed for the mark to be awarded.

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Abbreviations

AEF/OE	Any Equivalent Form (of answer is equally acceptable) / Or Equivalent
AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
CAO	Correct Answer Only (emphasising that no 'follow through' from a previous error is allowed)
CWO	Correct Working Only
ISW	Ignore Subsequent Working
SOI	Seen Or Implied
SC	Special Case (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)
WWW	Without Wrong Working
AWRT	Answer Which Rounds To

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Question	Answer	Marks	Guidance
1(a)	1.5 m s^{-1}	**B1**	OE e.g. $\frac{3}{2}, \frac{12}{8}$.
		1	
1(b)	Work done = $25\cos 20 \times 12$	**M1**	For $25\cos 20 \times 12$ or $25\sin 20 \times 12$ or $25\cos 70 \times 12$ or $25\sin 70 \times 12$.
	282 J	**A1**	281.9077…
		2	
1(c)	35.2 W	**B1FT**	**FT** *their* (b) divided by 8 or **FT** $25\cos 20 \times$ *their* **(a)**. Allow 35.3 (from $\frac{282}{8}$). Note: 25×1.5 is **B0.** Do not accept 35.2 kW.
		1	

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Question	Answer	Marks	Guidance
2	$0.2\times5+0.1\times2=(0.2+0.1)v$	*M1	Attempt at conservation of momentum; correct number of terms but allow sign errors – use of *mg* scores **M1A0.**
	$v=4$	A1	
	Loss in KE $=\pm\left[\frac{1}{2}\times0.2\times5^2+\frac{1}{2}\times0.1\times2^2-\frac{1}{2}\times(0.2+0.1)\times(their\,4)^2\right]$ $\left[=\pm(2.5+0.2-2.4)\right]$	DM1	Allow sign errors only; correct number of terms; dimensionally correct.
	[KE lost =] 0.3 J	A1	Allow -0.3. Use of *mg* in momentum scores max **M1A0M1A0.**
		4	

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Question	Answer	Marks	Guidance
3			$\cos\theta = \frac{12}{13}$ or $\sin\theta = \frac{5}{13}$ (where θ is the angle between the string and vertical). Candidates may use the complementary angle to θ .
	Resolving in any direction to form an equation	**M1**	Resolving either vertically/horizontally or parallel/perpendicular to the string. Correct number of terms, allow sign errors, allow sin/cos mix; forces that need resolving should be resolved. **M0** for using an angle other than 23 (or better) or 67 (or better).
	$T \times \frac{12}{13} + 35 \times \frac{5}{13} = mg$ $\begin{bmatrix} 0.9230\ldots T + 35 \times 0.3846\ldots = mg \\ 0.9230\ldots T + 13.461\ldots = mg \end{bmatrix}$ OR $T = mg \times \frac{12}{13}$ $\left[T = mg \times 0.9230\ldots\right]$	**A1**	Allow $T\cos\theta + 35\sin\theta = mg$ with $\theta = 23$ or better (22.61986495) substituted OR $T = mg\cos\theta$ with $\theta = 23$ or better (22.61986495) substituted. Allow with their T or m if already found.
	$T \times \frac{5}{13} = 35 \times \frac{12}{13}$ $\begin{bmatrix} T \times 0.3846\ldots = 35 \times 0.9230\ldots \\ T \times 0.3846\ldots = 32.3076\ldots \end{bmatrix}$ OR $mg \times \frac{5}{13} = 35$ $\left[mg \times 0.3846\ldots = 35\right]$	**A1**	Allow $T\sin\theta = 35\cos\theta$ with $\theta = 23$ or better (22.61986495) substituted OR $mg\sin\theta = 35$ with $\theta = 23$ or better (22.61986495) substituted.

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Question	Answer	Marks	Guidance
3	$T = 84$ and $m = 9.1$	**A1**	Allow $T = 84.1$ and $m = 9.11$. Allow AWRT 84.0 for T and 9.10 for m.
	Special Case for use of Lami		
	$\frac{mg}{\sin 90} = \frac{35}{\sin(180 - 22.6\ldots)} = \frac{T}{\sin(90 + 22.6\ldots)}$	**M1**	Attempt at one pair but allow with 2 'correct' angles but with the wrong force.
		A1	For one correct pair with $\theta = 23$ or better (22.61986495).
		A1	For all three correct with $\theta = 23$ or better (22.61986495).
	$T = 84$ and $m = 9.1$	**A1**	Allow $T = 84.1$ and $m = 9.11$. Allow AWRT 84.0 for T and 9.10 for m.
		4	

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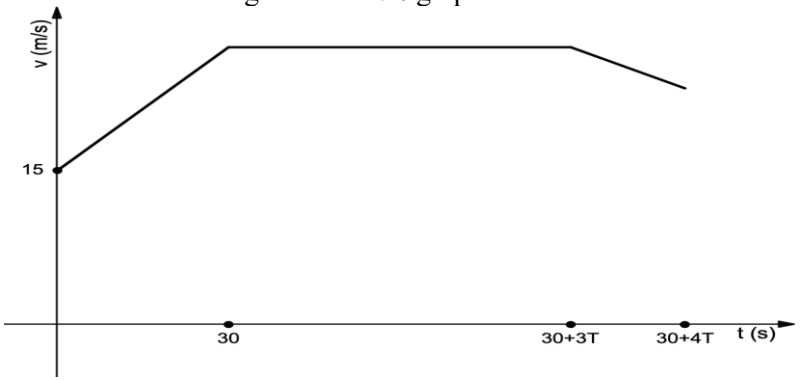
Question	Answer	Marks	Guidance
4(a)	Correct three-line segments for *v*-*t* graph  	**B1**	First line segment with positive gradient starting on the positive vertical axis, second line segment horizontal (parallel to t -axis) and third line segment with negative gradient, stopping before the horizontal axis. If the third line continues and touches the t -axis, there must be some indication that speed of the car at B is not 0.
	Values/expressions labelled on axes correctly	**B1**	15 correct on vertical axis; 30, 30 + 3T and 30 + 4T correctly labelled on horizontal axis.
		2	

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Question	Answer	Marks	Guidance
4(b)	Speed after 30 seconds = $15+0.4\times30\left[=27\right]$	**B1**	
	Speed at B is $their\,27+\left(-0.2\right)T$	***M1**	Use of $v=u+at$ using their speed after 30 seconds for u, $t=T$ and $a=\pm0.2$.
	Attempt at distance from A to B and equate to 2750	***M1**	Using the combined area below the three line segments; using *their* 27.
	$\frac{1}{2}\left(15+27\right)\times30+27\times3T+\frac{1}{2}\left\{\left(27-0.2T\right)+27\right\}\times T=2750$	**A1**	Correct (un-simplified) equation for T.
	$0.1T^2-108T+2120=0\Rightarrow T=\ldots$	**DM1**	Re-arranging and attempting to solve their three-term quadratic equation in T. If method seen, must be using correct formula OR if factorising, two terms must be correct for their three-term quadratic when expanding brackets. If no method seen, must have at least one correct value for their three-term quadratic for this mark.
	$T=20$ only	**A1**	If $T=1060$ also stated, then must be rejected.
		6	
4(c)	Speed at B is $\left(their\,27\right)+\left(-0.2\right)\times\left(their\,20\right)\left[=23\right]$	***M1**	Use of $v=u+at$ using their speed after 30 seconds from **(b)**, their T from **(b)** and $a=\pm0.2$.
	Distance from B to C is s where $0^2=\left(their\,23\right)^2+2\times\left(-0.5\right)\times s$ and attempt to solve for s	**DM1**	Use of $v^2=u^2+2as$ with $v=0$ and $a=-0.5$ and their speed at B for u (if correct $s=529$).
	Total distance is [529 + 2750 =] 3279 m	**A1**	Condone 3280 m.
		3	

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Question	Answer	Marks	Guidance
5(a)	$5g - T_{BC} = 5 \times 2$	**M1**	Attempt at N2L for C – correct number of terms but allow sign errors (but must be using correct mass).
	$T_{BC} - T_{AB} = 4 \times 2$	**M1**	Attempt at N2L for B – correct number of terms but allow sign errors (but must be using correct mass). Allow with their T_{BC}.
	$T_{BC} = 40$ N and $T_{AB} = 32$ N	**A1**	Both correct.
		3	
5(b)	$T_{AB} - F - 3g \sin 30 = 3 \times 2$	***M1**	Attempt at N2L on A – correct number of terms but allow sign errors; allow sin/cos mix (but must be using correct mass). For reference: $F = 11$.
	$R = 3g \cos 30$	**B1**	Correct expression for normal contact force at A.
	their $32 - \mu \times 3g \cos 30 - 3g \sin 30 = 3 \times 2$ and attempt to solve for μ	**DM1**	Use of $F = \mu R$ (where R is a component of weight) and their T_{AB} to obtain an equation in μ only and solve for μ.
	$\mu = 0.423$	**A1**	$\frac{11\sqrt{3}}{45}$.
		4	

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Question	Answer	Marks	Guidance
5(c)	Distance travelled by A in first 1.5 seconds is $\frac{1}{2}\times 2\times 1.5^2\ [=2.25]$	**B1**	
	When string breaks A is moving at a speed of 3 (m s^{-1})	**B1**	
	$-F-3g\sin 30=3a\left[a=-\frac{26}{3}\right]$	***M1**	Attempt at N2L for A – correct number of terms but allow sign errors, and cos/sin mix.
	$0=3^2+2\times(\textit{their } a)\times s\left[s=\frac{27}{52}\right]$	**DM1**	Attempt at finding the distance travelled by A up the plane after the string breaks using $v^2=u^2+2as$ (or other complete method) with $v=0, u=3$ and their negative acceleration.
	Total distance travelled by A up the plane is $\left[2.25+\frac{27}{52}=\right]2.77$ m	**A1**	$\frac{36}{13}, 2.769230789\ldots$
		5	

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Question	Answer	Marks	Guidance
6(a)	Attempt to differentiate $(v=)\left(2t+1\right)^{\frac{3}{2}}-2t^2$	***M1**	Decrease power by 1 and a change in coefficient in at least one term; $a=\frac{v}{t}$ is **M0**.
	$\left(\frac{\mathrm{d}v}{\mathrm{d}t}=\right)\frac{3}{2}\left(2t+1\right)^{\frac{3}{2}-1}\times 2-2\times 2t^{2-1}\left[=3\left(2t+1\right)^{\frac{1}{2}}-4t\right]$	**A1**	Allow un-simplified.
	$\frac{\mathrm{d}v}{\mathrm{d}t}=0\Rightarrow 3\left(2t+1\right)^{\frac{1}{2}}-4t=0\Rightarrow 9\left(2t+1\right)=16t^2$	**DM1**	Setting their derivative (of the form $p\left(2t+1\right)^{\frac{1}{2}}-qt$ where $p\neq 0, q\neq 0$) equal to zero and uses a correct method to form an equation without square roots involved, which would lead to a quadratic in t.
	$16t^2-18t-9=0\Rightarrow t=\ldots$	**DM1**	Solving correctly their three-term quadratic in t (must be using correct formula OR if factorising, two terms must be a correct multiple of their three-term quadratic when expanding brackets e.g. $16t^2-18t-9=0$ followed by $\left(t-\frac{3}{2}\right)\left(t+\frac{3}{8}\right)=0$ is OK for **M1**), to obtain (at least) one positive value of t. Must get a value of t such that $0<t<3$. For reference $t=1.5\left(t=-\frac{3}{8}\right)$. Dependent on both previous **M** marks. If no method seen, must have at least one correct positive value for their three-term quadratic for this mark.

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Question	Answer	Marks	Guidance
6(a)	Maximum velocity is 3.5 m s^{-1} ONLY	**A1**	CWO. Using T&I on $(2t+1)^{\frac{3}{2}}-2t^2$ to find a maximum is 0 marks. Using T&I on $9(2t+1)=16t^2$ can be awarded full marks for a fully correct solution.
	Special case for verification of $t=1.5$		
	Attempt to differentiate $(v=)(2t+1)^{\frac{3}{2}}-2t^2$	***M1**	Decrease power by 1 and a change in coefficient in at least one term; $a=\frac{v}{t}$ is **M0**.
	$\left(\frac{\mathrm{d}v}{\mathrm{d}t}=\right)\frac{3}{2}(2t+1)^{\frac{3}{2}-1}\times 2-2\times 2t^{2-1}\left[=3(2t+1)^{\frac{1}{2}}-4t\right]$	**A1**	Allow un-simplified.
	Verification of $t=1.5$ Must see $3(2\times 1.5+1)^{\frac{1}{2}}-4\times 1.5=0$ or better	**DB2**	Dependent on previous **M1A1**. OE.
	Maximum velocity is 3.5 m s^{-1} ONLY	**DB1**	Dependent on previous **M1A1B2**. CWO.
		5	

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Question	Answer	Marks	Guidance
6(b)	Attempt to integrate $(v=)(2t+1)^{\frac{3}{2}}-2t^2$	*M1	Increase power by 1 and a change in coefficient in at least one term; $s=vt$ is **M0**.
	$(s=)\dfrac{(2t+1)^{\frac{3}{2}+1}}{\left(\frac{3}{2}+1\right)\times 2}-\dfrac{2t^{2+1}}{2+1}(+c)\left[=\dfrac{(2t+1)^{\frac{5}{2}}}{5}-\dfrac{2t^3}{3}(+c)\right]$	A1	Allow un-simplified.
	Substitute $t = 1.5$ and $t = 0$ OR evaluate $c(\neq 0)$ using $t=0$ and substitute $t = 1.5$	DM1	Use of $t = 0$ and *their* 1.5 correctly (in their integrated expression) ONLY; $F(their 1.5)-F(0)$; *their* 1.5 must have come from an attempt at differentiation in **(a)** hence dependent on the first **M1** in **(a)**. Where *their* t is such that $0<t<3$. For reference $c=-0.2$.
	Distance $\left[=\left(\frac{32}{5}-\frac{9}{4}\right)-\left(\frac{1}{5}-0\right)\right]=3.95$ or $\frac{79}{20}$ m	A1	CWO. If no integration seen allow **SCB1** for 3.95. For reference $c=-0.2$.
		4	

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Question	Answer	Marks	Guidance
7	Apply the work-energy principle for the motion from A to B to form an equation in one variable only	***M1**	Correct number of relevant terms, allow sign errors and sin/cos mix. Dimensionally correct, terms that need a component should have a component.
	$\frac{1}{2}\times 3\times 8^2 - 3gd\sin 30 = \frac{\sqrt{3}}{12}\times 3g\cos 30\times d$ (where d is the distance AB) $\left[96-15d=3.75d\right]$	**A1**	**A1** for correct LHS.
		A1	**A1** for correct RHS.
	For either $d = 5.12$ m **or** work done against friction is 19.2 J	**A1**	Either value stated or clearly implied by later working. If using N2L then **M0**, but **SCB1** only (see below).
	$\frac{1}{2}\times 3\times v^2 = \frac{1}{2}\times 3\times 8^2 - 2\times(\textit{their}\,19.2)$ $\left[1.5v^2 = 96-38.4\right]$ OR $\frac{1}{2}\times 3\times v^2 + (\textit{their}\,19.2) = 3g\times(\textit{their}\,5.12)\times\sin 30$ $\left[1.5v^2+19.2=76.8\right]$ OR $\frac{1}{2}\times 3\times v^2 + (\textit{their}\,5.12)\times\frac{\sqrt{3}}{12}\times 3g\cos 30 = 3g\times(\textit{their}\,5.12)\times\sin 30$ $\left[1.5v^2+19.2=76.8\right]$	**DM1**	Either consider the total work done against friction from A to B **and** B to A or, consider motion from B to A. In both cases must have the correct number of terms but allow sign errors and cos/sin mix. Dimensionally correct, terms that need a component should have a component. Dependent on previous **M1** or previous **SCB1**.

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Question	Answer	Marks	Guidance
7	$v = 6.20$ m s^{-1} ONLY	**A1**	$\frac{8\sqrt{15}}{5}, 6.196773354\ldots$ must be positive. If using N2L then **M0**, but **SCB1** only (see below). Allow 6.2 from CWO. A 3sf answer of 6.19 becoming 6.2 is **A0**. This mark is dependent on all previous 5 marks awarded or on the **SCB1** and the previous **M1**.
	Special case for use of N2L for motion up the plane		
	$3a = \pm\left(3g \times \frac{1}{12}\sqrt{3} \times \cos 30 + 3g \sin 30\right) \rightarrow a = \pm 6.25$ and then $0^2 = 8^2 + 2(-6.25)s \rightarrow s = 5.12$	***B1**	
	Special case for use of N2L for motion down the plane		
	$3a = 3g \sin 30 - 3g \times \frac{1}{12}\sqrt{3} \times \cos 30 \rightarrow a = 3.75$ and then $v^2 = 0^2 + 2 \times 3.75 \times 5.12 \rightarrow v = 6.20$	**DB1**	
		6	

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