

Cambridge International AS & A Level

MATHEMATICS**9709/41**

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.

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.

This document consists of **15** printed pages.

PUBLISHED**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.

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.

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

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	More information required
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	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

Annotation	Meaning
DM1	Dependent on the previous M1 mark(s)
	Follow through
	Indicate working that is right or wrong
Highlighter	Highlight a key point in the working
	Ignore subsequent work
	Judgement
	Judgement
	Method mark awarded zero
	Method mark awarded one
	Method mark awarded two
	Misread
	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.
	Judgment made by the PE
	Premature approximation
	Special case
	Indicates that work/page has been seen

Annotation	Meaning
	Error in number of significant figures
	Correct
	Transcription error
	Correct answer from incorrect working

PUBLISHED**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.

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	$R = 12g \cos 20$	B1	112.7631145.
	$T - F - 12g \sin 20 = 12 \times 2$	*M1	For use of N2L with 4 terms. Allow sign errors. Allow sin/cos mix. Allow g missing. Allow with their Friction or just F .
	$T - 0.4 \times 12g \cos 20 - 12g \sin 20 = 12 \times 2$ [$T - 45.1052... - 41.0424... = 24$]	DM1	Use of $F = 0.4R$ where R is a component of weight, to get an equation in T only.
	Tension = 110 N [110.147...]	A1	AWRT 110 CWO.
		4	

Question	Answer	Marks	Guidance
2	$P + 5 \sin 60 - 10 \sin 30 = 0$	M1	For resolving in direction of P . 3 terms; allow sign errors and allow sin/cos mix.
	$P = 5 - 5 \frac{\sqrt{3}}{2}$ or 0.670 [0.66987...]	A1	Must be positive.
	$Q = \pm(10 \cos 30 - 5 \cos 60)$	M1	For resolving in direction of Q . 3 terms; allow sign errors and allow sin/cos mix.
	$Q = 10 \frac{\sqrt{3}}{2} - \frac{5}{2}$ or 6.16 [6.16025...]	A1	Must be positive.
		4	

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Question	Answer	Marks	Guidance
3(a)	Velocity at $t = 10$ is $8 \text{ [m s}^{-1}\text{]}$	B1	
	$\frac{1}{2} \times 8(T - 40) = 80$ OR $\frac{1}{2} \times 8 \times t = 80 \text{ } [\Rightarrow t = 20] \text{ and } T = \textit{their } t + 40$	M1	Attempt to find time for deceleration. Using <i>their</i> 8.
	Total time = 60s	A1	
		3	
3(b)	Distance after 10s = 55m	B1FT	FT <i>their</i> 8 15 + 5v .
	Distance after 40s = 295m	B1FT	FT <i>their</i> 8 15 + 35v .
		B1	For at least one quadratic the right way up or a straight line with positive gradient between $t = 10$ and $t = 40$.
		B1	For fully correct, smooth and continuous at $t = 10$ and $t = 40$. Ignore values on s axis. Ignore curve for $t > 60$ if shown on t -axis.
		4	

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Question	Answer	Marks	Guidance
4(a)(i)	$\frac{P}{30} - 1600 = 0 \Rightarrow P = 48000$ only	B1	
		1	
4(a)(ii)	$\frac{40000}{16} - 1600 = 18000a$	M1	For use of N2L with 3 dimensionally correct relevant terms. Allow sign errors. Allow $\frac{40}{16}$.
	Acceleration = 0.05 ms^{-2}	A1	
		2	
4(b)	For attempt to resolve up the hill to form an equation	M1	3 relevant terms, allow sign errors, allow sin/cos mix, allow g missing. Allow $\frac{120}{20}$.
	$\frac{120000}{20} - 1600 - 18000g \sin \alpha = 0$	A1	
	$\alpha = 1.40$ [1.4007...]	A1	
		3	

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Question	Answer	Marks	Guidance
5(a)	$\frac{1}{2}mu^2 = 16$	B1	
	$mu = 4$	B1	
	$u = 8, m = 0.5$	B1	
		3	
5(b)	$0.5 \times v = 0.5w + 1.25 \times 2w$ [$v = 6w$]	*M1	Using <i>their</i> value of m . Correct number of terms, allow sign errors.
	$\frac{1}{2} \times 0.5 \times v^2 - \left(\frac{1}{2} \times 0.5 \times w^2 + \frac{1}{2} \times 1.25 \times (2w)^2 \right) = \pm 25$	*M1	Using <i>their</i> value of m
	$9w^2 - \frac{1}{4}w^2 - 2.5w^2 - 25 = 0$ $\left[\frac{25}{4}w^2 = 25 \right]$	DM1	For equation in w or v only. Dependent on the two previous M marks
	$w = 2, v = 12$	A1	For both. Use of mg in momentum A0
		4	

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Question	Answer	Marks	Guidance
6(a)	Use of Newton's second law for P or Q or system	*M1	Allow g missing. Correct number of terms. Allow sin/cos mix. Allow sign errors. Allow using $\theta = 24^\circ$ or better.
	$0.6g \sin 30 - T = 0.6a$ $T - 0.3g \times 0.4 = 0.3a$ $0.6g \sin 30 - 0.3g \times 0.4 = (0.3 + 0.6)a$	A2	A1 For any one correct equation. A2 For any two correct equations.
	For attempt to solve for T or a	DM1	Must get to ' $T =$ ' or ' $a =$ '. From equations with the correct number of relevant terms.
	$a = 2 \text{ ms}^{-2}$ $T = 1.8\text{N}$	A1	Allow ± 2 .
		5	
6(b)	PE change for $P = \pm 0.3g \times 2 \times 0.4 [= \pm 2.4]$ PE change for $Q = \pm 0.6g \times 2 \sin 30 [= \pm 6]$	B1	For either.
	KE change $= \frac{1}{2} \times (0.3 + 0.6)v^2$	B1	
	$\frac{1}{2} \times 0.9v^2 = 0.6g \times 2 \sin 30 - 0.3g \times 2 \times 0.4 - 1.8$	M1	Attempt at work-energy equation. 4 terms; dimensionally correct. Allow sign errors. Do not allow missing g .
	Speed $= 2 \text{ ms}^{-1}$	A1	
	Special Case for use of N2L		
	$0.6g \sin 30 - 0.3g \sin 30 - 0.9 = 0.9a \rightarrow a = 1$	B1	
	$v^2 = 0^2 + 2 \times 1 \times 2 \rightarrow v = 2$	B1	
		4	

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Question	Answer	Marks	Guidance
7(a)	For an attempt at differentiation	*M1	The power of t must decrease by 1 in at least 1 term with a change of coefficient in the same term.
	$v = \frac{9}{2}t^{\frac{1}{2}} - 6$	A1	Allow un-simplified.
	$v = 0 \Rightarrow t = \frac{16}{9}$	M1	For attempt to solve for t . Condone sign errors and transposing fractions. Correct squaring of $\sqrt{t}$.
	$\left(3 \times 16^{\frac{3}{2}} - 6 \times 16\right) - \left(3 \times \left(\frac{16}{9}\right)^{\frac{3}{2}} - 6 \times \frac{16}{9}\right) \left[= \frac{896}{9} \right]$ Or $\left(3 \times \left(\frac{16}{9}\right)^{\frac{3}{2}} - 6 \times \frac{16}{9}\right) - 0 \left[= -\frac{32}{9} \right]$	DM1	Use of limits 0 and <i>their</i> $\frac{16}{9}$ or <i>their</i> $\frac{16}{9}$ and 16 correctly.
	For both i.e. $F(16) - F\left(\text{their} \frac{16}{9}\right) - \left[F\left(\text{their} \frac{16}{9}\right) - [F(0)]\right]$ OR $F(16) - F\left(\text{their} \frac{16}{9}\right) + \left[F\left(\text{their} \frac{16}{9}\right) - [F(0)]\right]$ OR $F(16) - 2 \times F\left(\text{their} \frac{16}{9}\right)$	DM1	
	$\frac{928}{9} \text{ m}$	A1	AWRT 103 m
		6	

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Question	Answer	Marks	Guidance
7(b)	For integration	*M1	The power of t must increase by 1 in at least 1 term with a change of coefficient in the same term.
	$v = 0.8t - 0.3t^2 + 7.5$	A1	
	$v = -9.6 \Rightarrow 0.3t^2 - 0.8t - 17.1 = 0$	DM1	For using $v = -9.6$ where $v = pt + qt^2 + r$ where $p \neq 0$ and $q \neq 0$ (no restriction for r) and attempt to solve for t .
	$t = 9 \left[\text{or } -\frac{19}{3} \right]$	A1	
	$s = 0.4t^2 - 0.1t^3 + 7.5t (+c)$	B1FT	FT their v which is a 3 term quadratic in t .
	At $t = 9 s_x = 3 \times 9^{\frac{3}{2}} - 6 \times 9 = 27$	B1	
	At $t = 9 s_y = 0.4 \times 9^2 - 0.1 \times 9^3 + 7.5 \times 9 = 27$	B1	
		7	

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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.

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WWW	Without Wrong Working
AWRT	Answer Which Rounds To

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 <i>their</i> (b) divided by 8 or FT $25 \cos 20 \times \textit{their(a)}$. Allow 35.3 (from $\frac{282}{8}$). Note: 25×1.5 is B0 . Do not accept 35.2 kW.
		1	

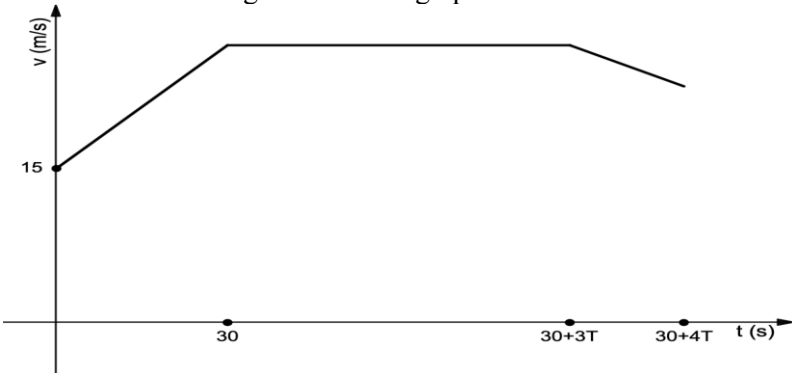
Question	Answer	Marks	Guidance
2	$0.2 \times 5 + 0.1 \times 2 = (0.2 + 0.1)v$	*M1	Attempt at conservation of momentum; correct number of terms but allow sign errors – use of <i>mg</i> scores M1A0 .
	$v = 4$	A1	
	$\text{Loss in KE} = \pm \left[\frac{1}{2} \times 0.2 \times 5^2 + \frac{1}{2} \times 0.1 \times 2^2 - \frac{1}{2} \times (0.2 + 0.1) \times (their\ 4)^2 \right]$ $[= \pm (2.5 + 0.2 - 2.4)]$	DM1	Allow sign errors only; correct number of terms; dimensionally correct.
	[KE lost =] 0.3 J	A1	Allow –0.3 . Use of <i>mg</i> 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).
	$T \times \frac{12}{13} + 35 \times \frac{5}{13} = mg$ $\left[\begin{array}{l} 0.9230...T + 35 \times 0.3846... = mg \\ 0.9230...T + 13.461... = mg \end{array} \right]$ OR $T = mg \times \frac{12}{13}$ [$T = mg \times 0.9230...$]	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.
	$T \times \frac{5}{13} = 35 \times \frac{12}{13}$ $\left[\begin{array}{l} T \times 0.3846... = 35 \times 0.9230... \\ T \times 0.3846... = 32.3076... \end{array} \right]$ OR $mg \times \frac{5}{13} = 35$ [$mg \times 0.3846... = 35$]	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 AWR 84.0 for T and 9.10 for m .
	Special Case for use of Lami		
	$\frac{mg}{\sin 90} = \frac{35}{\sin(180 - 22.6\dots)} = \frac{T}{\sin(90 + 22.6\dots)}$	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 AWR 84.0 for T and 9.10 for m .
		4	

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 = $15 + 0.4 \times 30 [= 27]$	B1	
	Speed at B is <i>their</i> $27 + (-0.2)T$	*M1	Use of $v = u + at$ using their speed after 30 seconds for u , $t = T$ and $a = \pm 0.2$.
	Attempt at distance from A to B and equate to 2750	*M1	Using the combined area below the three line segments; using <i>their</i> 27.
	$\frac{1}{2}(15 + 27) \times 30 + 27 \times 3T + \frac{1}{2}\{(27 - 0.2T) + 27\} \times T = 2750$	A1	Correct (un-simplified) equation for T .
	$0.1T^2 - 108T + 2120 = 0 \Rightarrow T = \dots$	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 $(\text{their } 27) + (-0.2) \times (\text{their } 20) [= 23]$	*M1	Use of $v = u + at$ using their speed after 30 seconds from (b) , their T from (b) and $a = \pm 0.2$.
	Distance from B to C is s where $0^2 = (\text{their } 23)^2 + 2 \times (-0.5) \times s$ 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} .
	$T_{BC} = 40 \text{ N}$ and $T_{AB} = 32 \text{ N}$	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 .
	<i>their</i> $32 - \mu \times 3g \cos 30 - 3g \sin 30 = 3 \times 2$ 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.
	$0 = 3^2 + 2 \times (\text{their } a) \times s \left[s = \frac{27}{52} \right]$	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 $\left[2.25 + \frac{27}{52} = \right] 2.77 \text{ m}$	A1	$\frac{36}{13}, 2.769230789 \dots$
		5	

Question	Answer	Marks	Guidance
6(a)	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 .
	$\left(\frac{dv}{dt} = \right) \frac{3}{2}(2t+1)^{\frac{3}{2}-1} \times 2 - 2 \times 2t^{2-1} \left[= 3(2t+1)^{\frac{1}{2}} - 4t \right]$	A1	Allow un-simplified.
	$\frac{dv}{dt} = 0 \Rightarrow 3(2t+1)^{\frac{1}{2}} - 4t = 0 \Rightarrow 9(2t+1) = 16t^2$	DM1	Setting their derivative (of the form $p(2t+1)^{\frac{1}{2}} - qt$ 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 .
	$16t^2 - 18t - 9 = 0 \Rightarrow t = \dots$	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.

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 .
	$\left(\frac{dv}{dt} = \right) \frac{3}{2}(2t+1)^{\frac{3}{2}-1} \times 2 - 2 \times 2t^{2-1} \left[= 3(2t+1)^{\frac{1}{2}} - 4t \right]$	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 .
	$(s =) \frac{(2t+1)^{\frac{3}{2}+1}}{\left(\frac{3}{2}+1\right) \times 2} - \frac{2t^{2+1}}{2+1} (+c) \left[= \frac{(2t+1)^{\frac{5}{2}}}{5} - \frac{2t^3}{3} (+c) \right]$	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 <i>their</i> 1.5 correctly (in their integrated expression) ONLY; $F(\text{their } 1.5) - F(0)$; <i>their</i> 1.5 must have come from an attempt at differentiation in (a) hence dependent on the first M1 in (a) . Where <i>their</i> t is such that $0 < t < 3$. For reference $c = -0.2$.
	Distance $\left[= \left(\frac{32}{5} - \frac{9}{4} \right) - \left(\frac{1}{5} - 0 \right) \right] = 3.95 \text{ or } \frac{79}{20} \text{ m}$	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) $[96 - 15d = 3.75d]$	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).
	$\frac{1}{2} \times 3 \times v^2 = \frac{1}{2} \times 3 \times 8^2 - 2 \times (\text{their } 19.2)$ $[1.5v^2 = 96 - 38.4]$ OR $\frac{1}{2} \times 3 \times v^2 + (\text{their } 19.2) = 3g \times (\text{their } 5.12) \times \sin 30$ $[1.5v^2 + 19.2 = 76.8]$ OR $\frac{1}{2} \times 3 \times v^2 + (\text{their } 5.12) \times \frac{\sqrt{3}}{12} \times 3g \cos 30 = 3g \times (\text{their } 5.12) \times \sin 30$ $[1.5v^2 + 19.2 = 76.8]$	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 .

Question	Answer	Marks	Guidance
7	$v = 6.20 \text{ m s}^{-1}$ ONLY	A1	$\frac{8\sqrt{15}}{5}$, 6.196773354... 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	

Cambridge International AS & A Level

MATHEMATICS**9709/43**

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.

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.

This document consists of **19** printed pages.

PUBLISHED**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.

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.

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

Annotation	Meaning
DM1	Dependent on the previous M1 mark(s)
	Follow through
	Indicate working that is right or wrong
Highlighter	Highlight a key point in the working
	Ignore subsequent work
	Judgement
	Judgement
	Method mark awarded zero
	Method mark awarded one
	Method mark awarded two
	Misread
	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.
	Judgment made by the PE
	Premature approximation
	Special case
	Indicates that work/page has been seen

Annotation	Meaning
	Error in number of significant figures
	Correct
	Transcription error
	Correct answer from incorrect working

PUBLISHED**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.

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)	$0.1 \times 4u - 0.3 \times u = 0.1 \times 2 + 0.3 \times 4$ or $0.1 \times 4u - 0.3 \times u = 0.1 \times (-2) + 0.3 \times 4$	M1	For use of conservation of momentum once. Must have correct number of terms. Allow g included with all 4 masses and sign errors only.
	$u = 14$	A1	Must be positive.
	$u = 10$	A1	Must be positive. Allow Max M1 A1 A0 if g included with the masses. Note: $0.1 \times 4u - 0.3 \times u = 0.1 \times 2 + 0.3 \times (-4)$ leading to $u = 10$ (or -10) scores A0 . Maximum M1 A1 if more than 2 values of u stated.
		3	
1(b)	$\pm \left(\frac{1}{2} \times 0.1 \times (4 \times \text{their } 14)^2 + \frac{1}{2} \times 0.3 \times (\text{their } 14)^2 - \frac{1}{2} \times 0.1 \times 2^2 - \frac{1}{2} \times 0.3 \times 4^2 \right)$ $[= \pm (156.8 + 29.4 - 0.2 - 2.4)]$	M1	For expression or equivalent difference. Allow sign errors only. Using <i>their</i> 14 which is the larger of the 2 values found in part (a). If only one value of u found in part (a) then M0 . If no value for u substituted, then M0 .
	Largest loss = 183.6J	A1	Allow $-183.6, \pm \frac{918}{5}$. This mark is dependent on full marks in part (a) . Condone negative values for u and v used. If calculating both KE losses, then largest must be chosen for this mark. Condone ± 184 CWO.
		2	

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Question	Answer	Marks	Guidance
2	Attempt at Newton's Second law on either van, trailer or the system	*M1	Must have correct number of terms. Allow sign errors. Dimensionally correct.
	$T - 120 = 350 \times 0.4$ $2500 - X - T = 4500 \times 0.4$ $2500 - X - 120 = (4500 + 350) \times 0.4$	A1	Any 2 correct equations.
	Attempt to solve for either T or X	DM1	From equation(s) with correct number of dimensionally correct terms. Must get $T =$ or $X =$.
	$T = 260 \quad X = 440$	A1	Both correct.
		4	

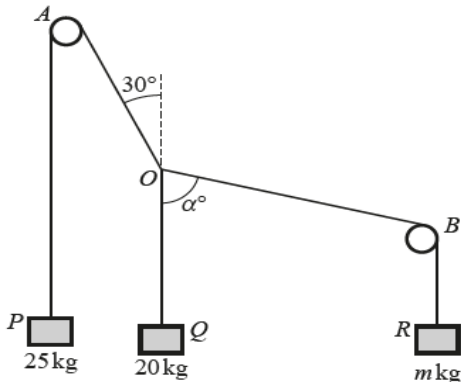
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Question	Answer	Marks	Guidance
3(a)	Velocity at $t = 20$ is $\left[5 + \frac{3}{4} \times 20 = \right] 20 \text{ m s}^{-1}$	B1	Allow if seen on diagram.
	Speed at $t = 50$ is 10 ms^{-1}	B1	When v is minimum. Allow if seen on diagram. Allow -10 .
	Displacement at $t = 40$ is $\frac{1}{2}(5 + \text{their } 20) \times 20 + \frac{1}{2} \times 20 \times \text{their } 20 [= 450]$ OR $\frac{1}{2}((\text{their } 20 - 5) \times 20) + 20 \times 5 + \frac{1}{2} \times 20 \times \text{their } 20 [= 450]$ OR Displacement at $t = 50$ is $\frac{1}{2}(5 + \text{their } 20) \times 20 + \frac{1}{2} \times (\text{their } 20 - 10) \times 30 [= 400]$	*M1	Correct method to find the displacement up to $t = 40$ or $t = 50$. Follow through <i>their</i> 20.
	$\frac{1}{2} \times (T - 40) \times \text{their } 10 = \text{their } 450$ OR $\frac{1}{2} \times (T - 50) \times \text{their } 10 + \frac{1}{2} \times 10 \times \text{their } 10 = \text{their } 450$ OR $\frac{1}{2} \times (T - 50) \times \text{their } 10 = \text{their } 400$	DM1	For an equation in T (or t) involving their displacement at either $t = 40$ or $t = 50$ and using <i>their positive</i> 10 which must have come from $\left \text{their } 20 + \left(\frac{0 - \text{their } 20}{20} \right) \times 30 \right $. Must lead to a value of $T > 0$ unless correctly recovered.
	$T = 130$	A1	Condone $t = 130$ or 130
		5	

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Question	Answer	Marks	Guidance
3(b)	$\text{Acceleration} = \frac{\text{their } 10}{\text{their } 130 - 50}$ OR $0 = (\text{their } (-10)) + a \times (\text{their } 130 - 50)$	M1	Correct method to find the acceleration using their 10 (or -10) and their T – dependent on both M marks in part (a) and must lead to a positive value for the acceleration.
	$\text{Acceleration} = \frac{1}{8} \text{ m s}^{-2} \text{ or } 0.125 \text{ m s}^{-2}$	A1	
		2	

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Question	Answer	Marks	Guidance
4	For resolving in either direction to form an equation – diagram for reference: 	*M1	Correct number of terms. Allow sin/cos mix. Allow sign errors. Allow g missing. Equation must be in terms of m and α only (so no marks until tensions replaced). For reference: $T_P = 25g$, $T_R = mg$, $T_Q = 20g$, $T_P \cos 30 = T_R \cos \alpha + T_Q$, $T_R \sin \alpha = T_P \sin 30$.
	$25g \cos 30 - 20g - mg \cos \alpha = 0$ [216.506... – 200 – 10m cos $\alpha = 0$]	A1	A0 if g missing.
	$25g \sin 30 - mg \sin \alpha = 0$ [125 – 10m sin $\alpha = 0$]	A1	A0 if g missing.
	$\alpha = \tan^{-1} \left(\frac{25g \sin 30}{25g \cos 30 - 20g} \right)$ OR $\alpha = \sin^{-1} \left(\frac{25g \sin 30}{(their\ m)g} \right)$	DM1	For attempt to find α . Must get to ' $\alpha =$ ' Must come from equations with the correct number of relevant terms.
	$mg = \sqrt{(25g \sin 30)^2 + (25g \cos 30 - 20g)^2}$ OR $m = \frac{25g \sin 30}{g \sin (their\ \alpha)}$	DM1	For attempt to find m or mg . Must get to ' $m =$ ' or ' $mg =$ ' OR finding the tension in string OR (for reference if correct is 126.085...) and then using $T_R = mg$. Must come from equations with the correct number of relevant terms.
	$\alpha = 82.5$ and $m = 12.6$	A1	AWRT 82.5, 12.6 ($\alpha = 82.4775...$ $m = 12.608...$) A0 if g missing from original equations.
		6	

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Question	Answer	Marks	Guidance
5(a)	$62500 = k \times 50^2 \times 50$ or $1250 = k \times 50^2$	M1	For use of Power = $DF \times v$ - allow 62.5×10^3 for 62500, allow $62500 = k \times 50^3$.
	$k = 0.5$	A1	AG – allow a correct equation followed by $k = 0.5$.
	$\frac{62500}{25} - 0.5 \times 25^2 = 2500a$ [$2500 - 312.5 = 2500a$]	M1	For N2L with 3 terms; dimensionally correct but allow sign errors. If using $\frac{62500}{50} (= 1250)$ for the DF then M0 .
	Acceleration = 0.875 m s^{-2}	A1	Allow $\frac{7}{8}$.
		4	

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Question	Answer	Marks	Guidance
5(b)	Attempt at Newton's second law at least once to form an equation	*M1	With 4 relevant terms; allow sign errors; Allow sin/cos mix; condone 30 with $5a$, 20 with a , but must be dimensionally correct.
	$\frac{62500}{30} - 0.5 \times 30^2 - 2500g \sin \theta = 2500a$ $[2083.33... - 450 - 25000 \sin \theta = 2500a]$ and $\frac{62500}{20} - 0.5 \times 20^2 - 2500g \sin \theta = 2500 \times 5a$ $[3125 - 200 - 25000 \sin \theta = 12500a]$	A2	A1 for either correct equation.
	$\frac{62500}{20} - 0.5 \times 20^2 - \left(\frac{62500}{30} - 0.5 \times 30^2 \right) = 10000a$	DM1	For attempt to solve for a or θ – from equations with the correct number of relevant terms.
	$\theta = 3[.00]$ and $a = 0.129$	A1	Allow $a = \frac{31}{240}$, 0.129167... Allow 0.130 (0.129973...) from using $\theta = 3$ but not 0.13 unless greater accuracy seen.
		5	

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Question	Answer	Marks	Guidance
6(a)	$R = 80g \times 0.6 [= 480]$	B1	Allow $80g \times \cos 53$ (or better for $\theta = 53.1301\dots$)
	$F = 0.1 \times 80g \times 0.6 [= 48]$	*M1	For use of $F = 0.1R$ with $R = 80g \times 0.6$ or $R = 80g \times 0.8$ or equivalent with $\cos 53$ or $\sin 53$ or better.
	$80g \times 0.8 - F = 80a \Rightarrow a = 7.4$	*M1	For attempt to find an equation for a using N2L with 3 terms; allow sign errors; allow sin/cos mix for the weight component with $\cos 53$ or $\sin 53$ or better. Allow F or their F .
	$v^2 = (0 +)^2 \times (their\ a) \times 5$	DM1	For attempt to find v^2 or v using their positive a .
	Velocity = 8.60 m s^{-1}	A1	Allow $\sqrt{74}$ but A0 for 8.6 if 3sf or better (8.6023...) answer not seen.
	Alternative for Q6(a) for candidates who use an energy method		
	$R = 80g \times 0.6 [= 480]$	B1	Allow $80g \times \cos 53$ (or better for $\theta = 53.1301\dots$).
	$F = 0.1 \times 80g \times 0.6 [= 48]$	*M1	For use of $F = 0.1R$ with $R = 80g \times 0.6$ or $R = 80g \times 0.8$, or equivalent with $\cos 53$ or $\sin 53$ or better.
	[Loss in] PE = $\pm 80g \times 5 \times 0.8 [= \pm 3200]$ OR work done [against] friction = $\pm 0.1 \times 80g \times 0.6 \times 5 [= \pm 240]$	B1	Allow $\cos 53$ or better for the 0.6 in the WD against friction term or $\sin 53$ or better for the 0.8 in the PE term.
	$80g \times 5 \times 0.8 - 0.1 \times 80g \times 0.6 \times 5 = \frac{1}{2} \times 80 \times v^2$ [$3200 - 240 = 40v^2$]	DM1	For attempt at work energy equation. 3 relevant terms; allow sign errors; allow sin/cos mix (using 53 or better) but must be dimensionally correct, terms that need a component should have a component. M0 if the distance in the WD against friction term is not 5.

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Question	Answer	Marks	Guidance
6(a)	Velocity = 8.60ms^{-1}	A1	Allow $\sqrt{74}$ but A0 for 8.6 if 3sf or better (8.6023...) answer not seen.
		5	
6(b)	Change in KE = $\pm\left(\frac{1}{2}\times 80\times 11^2 - \frac{1}{2}\times 80\times (their\ v^2)\right)$	B1FT	FT their v^2 from part (a) .
	Change in PE = $\pm 80g\times 2.5$ [= ± 2000]	B1	Including PE from A is B0 .
	$80g\times 2.5 - W = \frac{1}{2}\times 80\times 11^2 - \frac{1}{2}\times 80\times (their\ v^2)$ [$2000 - W = 4840 - 40\times (their\ v^2)$]	M1	For attempt at work energy equation. 4 relevant terms; allow sign errors but must be dimensionally correct. M0 if using change in PE from A to C.
	Work done = 120 J	A1	Allow 118(.4) from using 8.6(0) from part (a). Working must lead to a positive answer for the work done (so -120 oe is A0).
		4	

Question	Answer	Marks	Guidance
7(a)	$v = 0.6t + 0.6$	B1	Allow un-simplified.
	Velocity at $t = 4$ is 3 m s^{-1}	B1	
		2	

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Question	Answer	Marks	Guidance
7(b)(i)	For attempt at integration of $0.3t^{\frac{1}{2}}$ to $kt^{\frac{3}{2}}(+c)$	*M1	Answer must be of the form $kt^{\frac{3}{2}}$ where $k \neq 0$ or 0.3 Use of $v = at$ or $v = k_1(t-4)^{\frac{3}{2}} + \dots$ scores M0 . Do not penalise missing c .
	$their\ 3 = 0.2(4)^{\frac{3}{2}} + c$ leading to $c = \dots$ $\left[\Rightarrow v = 0.2t^{\frac{3}{2}} + 1.4 \right]$	DM1	Use of <i>their</i> 3 from part (a) and $t = 4$ to find c (for reference if correct then $c = 1.4$) OR using correct limits of 4 and T in their equation for v e.g. $\left[0.2t^{\frac{3}{2}} \right]_4^T = 0.2 \left(T^{\frac{3}{2}} - 8 \right)$.
	$14.2 = 0.2T^{\frac{3}{2}} + their\ 1.4$	DM1	For equating to 14.2. Allow in terms of t Dependent on both previous M marks OR equivalent e.g. $14.2 - their\ 3 = 0.2 \left(T^{\frac{3}{2}} - 8 \right)$.
	$T = 16$	A1	Allow 16 or $t = 16$.
		4	

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Question	Answer	Marks	Guidance
7(b)(ii)	Distance travelled in first 4 seconds = 7.2m	B1	
	$s = 0.08t^{\frac{5}{2}} + 1.4t$	*B1FT	For integrating their v from part (b)(i) correctly which must be of the form $\alpha t^{\frac{3}{2}} + \beta$ with $\alpha, \beta \neq 0$ – allow un-simplified.
	$\left(0.08(16)^{\frac{5}{2}} + 1.4 \times 16\right) - \left(0.08(4)^{\frac{5}{2}} + 1.4 \times 4\right)$ $[= 81.92 + 22.4 - 2.56 - 5.6 = 104.32 - 8.16 = 96.16]$	DM1	Correct use of limits 4 and <i>their</i> 16 (> 4) must be equivalent to $F(\text{their } 16) - F(4)$.
	Distance = 103.36 m	A1	Condone 103 or better CWO, $\frac{2584}{25}$. Do not ISW if, for example, $103.36 + 7.2 = 110.56$. If constant of integration c found, then must be correct, that is $c = -0.96$. If no integration seen than max B1 for 7.2 and B1 for 103 m or better.
		4	

Cambridge International AS & A Level

MATHEMATICS**9709/45**

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.

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.

This document consists of **23** printed pages.

PUBLISHED**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.

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.

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

Annotation	Meaning
DM1	Dependent on the previous M1 mark(s)
	Follow through
	Indicate working that is right or wrong
Highlighter	Highlight a key point in the working
	Ignore subsequent work
	Judgement
	Judgement
	Method mark awarded zero
	Method mark awarded one
	Method mark awarded two
	Misread
	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.
	Judgment made by the PE
	Premature approximation
	Special case
	Indicates that work/page has been seen

Annotation	Meaning
	Error in number of significant figures
	Correct
	Transcription error
	Correct answer from incorrect working

PUBLISHED**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.

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	$PE = \pm 25g \times 12 \sin 8 [= \pm 3000 \sin 8 = \pm 417.519 \dots]$	B1	If not seen separately allow B1 for $\pm(25g \sin 8 \pm 50) \times 12$.
	$KE = \pm \frac{1}{2} \times 25 \times 2.4^2 [= \pm 72]$	B1	If the candidate mistakenly thinks that the distance is 12m vertically upwards then allow only this mark.
	$WD = 25g \times 12 \sin 8 + \frac{1}{2} \times 25 \times 2.4^2 + 50 \times 12$	M1	Correct number of relevant terms with component included in PE term, dimensionally correct. Could have $12F$ in place of WD . Allow sign errors; allow sin/cos mix.
	$WD = 1090$ J Allow to subsequently find F (ISW) but A0 if state ‘work done = 90.793’	A1	1089.519303 Allow 1089–1090 J. OE.
	Alternative method using Newton’s second law		
	$2.4^2 = 0^2 + 2a \times 12 [a = 0.24]$	*M1	Or other suvat method using $u = 0, v = 2.4$ and $s = 12$.
	$F - 50 - 25g \sin 8 = 25 \times \text{their } a$ May have $\frac{W}{12}$ instead of F . May if correct see $F - 50 - 34.793 \dots = 6$ or $F = 90.793 \dots$	*DM1	For use of Newton’s second law with their value for a . Correct number of relevant terms with weight component included. Allow sign errors; allow sin/cos mix.
	Work done = <i>their</i> $F \times 12$	DM1	OE e.g. $F = \frac{W}{12}$ Dep on both M marks.
	Work done = 1090J	A1	Allow 1089–1090 J.
		4	

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Question	Answer	Marks	Guidance
2(a)	$1.5 \times 32 = (1.5 + 0.005)v$	M1	Conservation of momentum. Must have three non-zero terms. Allow sign errors. Must have correct masses with relevant velocities. Note: M1A0 if g included with the masses
	speed = 31.894 ms^{-1} Allow '31.894 = 31.9'	A1	ISW. Must be given to 3dp as specified in question.
		2	

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Question	Answer	Marks	Guidance
2(b)	$(1.5 + 0.005)g - 25000 = (1.5 + 0.005)a \rightarrow a = -16601.29568$	*M1	Use of N2L with correct number of relevant terms; allow sign errors, but masses must be added, not subtracted. Mass must be $(1.5 + 0.005)$.
	$0 = (their\ 31.894)^2 + 2 \times (their - 16601.29568)s$	DM1	Use of constant acceleration to get an equation in s using their negative a and their speed (allow rounded to 3sf or better). Must use suvat correctly.
	$s = 0.0306\text{ m}$	A1	0.030636983... Note: answer 0.0306184 from omitting weight terms in N2L giving $a = 16611.29...$ This gets M0M0A0 . Use of speed = 31.9 gives $s = 0.030649...$ which gets full credit if correctly obtained.
	Alternative method using energy		
	PE – work done against friction = $\pm((1.5 + 0.005)g - 25000)s [= \pm 24984.95s]$	B1	
	$((1.5 + 0.005)g - 25000)s = -\frac{1}{2} \times (1.5 + 0.005) \times (their\ 31.894)^2$	M1	Allow sign errors including in PE but all masses must be correct. Correct number of terms and dimensionally correct. Using their speed (allow rounded to 3sf or better).
	$s = 0.0306\text{ m}$	A1	0.030636983...
		3	

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Question	Answer	Marks	Guidance
3	$s_1 = 0.5 \times 30 \times t_1$ $s_3 = 0.5 \times 30 \times t_3$ $s_2 = 30 \times T$ Allow $s_1 = \frac{900}{2a_1}$ $s_3 = \frac{900}{2a_3}$ $s_2 = 30 \times T$	*M1	Use of suvat for displacement $s =$ for at least two of the three or for $s_{1+3} = 0.5 \times 30 \times (180 - T)$. Must not use the same variable for all three.
	$4800 = 15t_1 + 30t_2 + 15t_3$ $[= 15(180 - T) + 30T]$	DM1	Adding displacements in terms of times and equating to 4800. Allow if use 4.8 rather than 4800.
	$4800 = 15(180 - T) + 30T$ oe	A1	For correct equation in any time variable.
	$T = 140$	A1	Condone the assumption that magnitude of acceleration and deceleration are equal (which should come to 1.5) and allow full credit if everything else correct. Allow X or any other variable for time
	Distance 4200m	B1FT	FT their T $30 \times$ <i>their</i> T
	Alternative method for question 3		
	Use of a trapezium (may be indicated by diagram) Or $0.5 \times 30 \times (180 + T)$	M1	If no correct subsequent working, then allow M1 for trapezium drawn with height 30, base 180 and top of length T (do not need to indicate that area = 4800).
	$0.5 \times 30 \times (180 + T) = 4800$	B2	OE.
	$T = 140$	A1	Allow X or any other variable for time.
	Distance 4200m	B1FT	FT their T $30 \times$ <i>their</i> T .
		5	

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Question	Answer	Marks	Guidance
4(a)	Resolving either direction. Each force must have a component Note: $\sin \alpha = \frac{15}{17}$, $\cos \alpha = \frac{8}{17}$ May see $X = \pm(51\cos \alpha + 34\cos \alpha - 17\sin \alpha)$ and $Y = \pm(51\sin \alpha - 34\sin \alpha - 17\cos \alpha)$ but no marks until values of $\sin \alpha$ and $\cos \alpha$ used.	*M1	With correct number of relevant terms. Allow consistent sin/cos mix but must have more than simply $\sin \alpha$ and / or $\cos \alpha$. Allow sign errors. Do not allow ‘forces to the left = forces to the right’ e.g. $51 \times \frac{8}{17} + 34 \times \frac{8}{17} = 17 \times \frac{15}{17}$ unless subsequently ‘corrected’. Allow $\sin\left(\tan^{-1}\frac{15}{8}\right)$ etc. for M1A1A1 if correct.
	$[X = R\cos \beta =] \pm \left(51 \times \frac{8}{17} + 34 \times \frac{8}{17} - 17 \times \frac{15}{17}\right) [= \pm(24 + 16 - 15) = \pm 25]$	A1	Allow use of 62° or 28° or better [leading to $\pm 24.8949\dots$ or better]. Note: consistent sin/cos mix leads to 67 which gets M1A0A0 .
	$[Y = R\sin \beta =] \pm \left(51 \times \frac{15}{17} - 34 \times \frac{15}{17} - 17 \times \frac{8}{17}\right) [= \pm(45 - 30 - 8) = \pm 7]$	A1	Allow use of 62° or 28° or better [leading to $\pm 7.0290\dots$ or better]. Note: consistent sin/cos mix leads to -7 which gets M1A0A0 .
	$R = \sqrt{25^2 + 7^2}$ Or $R = \frac{25}{(\cos \text{their } \beta)}$ or $\frac{7}{(\cos \text{their } \beta)}$ Or $R = \frac{7}{(\sin \text{their } \beta)}$ or $\frac{25}{(\sin \text{their } \beta)}$	DM1	Attempt to solve for R Attempt to find R . From equations with the correct number of relevant terms. All forces resolved as appropriate but allow consistent sin/cos muddle. Allow use of their β provided correctly derived from equations with the correct number of relevant terms.

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Question	Answer	Marks	Guidance
4(a)	$\beta = \tan^{-1} \frac{7}{25}$ or $\beta = \tan^{-1} \frac{25}{7}$ Or $\beta = \cos^{-1} \frac{25}{\text{their } R}$ or $\cos^{-1} \frac{7}{\text{their } R}$ Or $\beta = \sin^{-1} \frac{7}{\text{their } R}$ or $\sin^{-1} \frac{25}{\text{their } R}$	DM1	Attempt to solve for β . From equations with the correct number of relevant terms. All forces resolved as appropriate but allow consistent sin/cos muddle. Allow use of their R provided correctly derived from equations with the correct number of relevant terms.
	$R = 26[.0] \text{ N}$ or $\sqrt{674}$ $\beta = 15.6^\circ$ above positive x – axis Allow 15.6° right of positive x – axis, anticlockwise 15.6 from positive x axis ‘ 74.4° clockwise from the y -axis’ ‘ 74.4° to right of the y -axis’ Allow 15.6° North of East or ‘ 15.6° above the east’. Bearing of $[0]74.4^\circ$, $N74.4^\circ E$ Do not allow ‘East north 15.6° ’	A1	Both correct Allow resultant sketched with angle indicated and arrowed. If not specified in working, please check original diagram to see if direction specified there instead. Allow any explanation of direction that could be drawn uniquely.
	Alternative method resolving in the directions of the 34N and 17N forces		
	Resolving either direction.	M1	With correct number of relevant terms. Allow consistent sin/cos mix but must have more than simply $\sin \alpha$ and / or $\cos \alpha$. Allow sign errors. Do not allow ‘forces to the left = forces to the right’ unless subsequently correct.
	$\pm(17 - 51\cos 33.855\dots)[= \mp 25.3529\dots]$	A1	
	$\pm(34 - 51\cos 56.144\dots)[= \pm 5.5882\dots]$	A1	
	$R = \sqrt{25.3529\dots^2 + 5.5882\dots^2}$	M1	Attempt to solve for R .
	$\beta = \tan^{-1} \frac{5.5882\dots}{-25.3529\dots} + \tan^{-1} \frac{8}{15}$	M1	OE. Attempt to solve for β .

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Question	Answer	Marks	Guidance
4(a)	$R = 26[.0]\text{N}$ $\beta = 15.6^\circ$ above positive x – axis or otherwise as above	A1	
		6	
4(b)	$P \times \frac{15}{17} - 34 \times \frac{15}{17} - 17 \times \frac{8}{17} = 0$ or $P \times \frac{15}{17} = 34 \times \frac{15}{17} + 17 \times \frac{8}{17}$ or $P \times \frac{15}{17} = 38$ or $\frac{P - 34}{17} = \frac{8}{15}$	M1	With correct number of relevant terms. Allow sign errors. Do not allow sin/cos mix. Must be an equation, NOT just an expression. May see $P \sin \alpha - 34 \sin \alpha - 17 \cos \alpha = 0$ but no marks until values of $\sin \alpha$ and $\cos \alpha$ used
	$P = 43.1$	A1	Allow $\frac{646}{15}$.
		2	

Question	Answer	Marks	Guidance
5(a)	$[R] = D = \frac{24000}{32} [= 750]$	B1	OE e.g. $24000 = D \times 32$
	Attempt at N2L $\frac{28000}{36} - R = 1500 \times a$	M1	Use of N2L with 3 relevant terms; allow sign errors. Allow R or <i>their</i> R .
	$\frac{28000}{36} - \frac{24000}{32} = 1500 \times a$ or $777.777\dots - 750 = 1500 \times a$	A1	
	$a = 0.0185 \text{ ms}^{-2}$ or $\frac{1}{54} \text{ ms}^{-2}$	A1	
		4	

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Question	Answer	Marks	Guidance
5(b)	$20000 = (340 + 4v) \times v$ or $\frac{20000}{v} = 340 + 4v$	*M1	Use of power = $F \times v$ OE, with F given in question but allow miscopy of F . Allow if candidate uses 20 instead of 20000.
	Attempt to solve a three-term quadratic to obtain at least one value of v .	DM1	Correct quadratic is $4v^2 + 340v - 20000 = 0$. Must be at least one correct real value for their 3 Three-term quadratic. If no solving seen, must have three-terms and one correct value for their three-term quadratic to be awarded this mark. Allow if candidate uses 20 instead of 20000.
	Speed = 40 m s^{-1} (only)	A1	No solving needed for A1 if no wrong working.
		3	

Question	Answer	Marks	Guidance
6(a)	$t = 2.5$ or $\frac{5}{2}$	B1	
	$t = 12.5$ or $\frac{25}{2}$	B1	
		2	

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Question	Answer	Marks	Guidance
6(b)	$[a =]2(15 - 2t)(-2)[= 8t - 60]$	*M1	For attempt at differentiation. Must have expression of the form $pt + q$ with $p \neq 0, p \neq 4, q \neq 0$. p and q need not be simplified. Use of $a = \frac{v}{t}$ scores M0 .
	$8t - 60 = 0$ AND $(15 - 2t)^2 = 0$ AND attempt to solve at least one of these equations. Allow $225 - 60t + 4t^2 = 0$ Allow their $a = 0$.	DM1	No need for working to solve either equation. Could have one of the two equations with <i>their</i> 7.5 substituted rather than t .
	$t = 7.5$ (twice)	A1	AG CWO Any error seen A0 . Allow substitution of 7.5 for t instead into second equation after first one solved. i.e. $(15 - 2 \times 7.5)^2 = 0$ OR $8 \times 7.5 - 60 = 0$ OE. Candidates who solve $a = v$ would only get the first M1 unless they show that 7.5 gives zero for either acceleration or velocity.
		3	

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Question	Answer	Marks	Guidance
6(c)	For attempt at integration $[s =] \int (4t^2 - 60t + 225) dt$	*M1	The power of t must increase by 1 with a change of coefficient in the same term. Use of $s = vt$ scores M0 . E.g. $s = a(15 - 2t)^3$ for $a \neq 1$ or $a \neq 0$
	$[s =] \frac{4}{3}t^3 - 30t^2 + 225t [+c][c = 0]$ or $[s =] \frac{1}{3}(15 - 2t)^3 \times \frac{1}{-2} [+c][c = 562.5]$	A1	Correct integral, allow un-simplified. If constant wrong can still get A1 .
	$s = \left[\frac{4}{3}t^3 - 30t^2 + 225t \right]_0^{7.5} = \frac{4}{3} \times 7.5^3 - 30 \times 7.5^2 + 225 \times 7.5 [-0]$ or $s = \left[\frac{1}{3}(15 - 2t)^3 \times \frac{1}{-2} \right]_0^{7.5} = 0 - \frac{1}{3}(15 - 2 \times 0)^3 \times \frac{1}{-2}$	DM1	Correct use of limits (their t from part (b) and zero) and their integral (but allow one mistake in calculation). Could instead find $c = 562.5$ then substitute their $t = 7.5$. If they go on to add another displacement area to correctly obtained value allow M1A0 .
	$s = 562.5$ or $\frac{1125}{2}$ or 563	A1	Allow DM1A1 without working if correct answer after finding correct integral. SCB1 for correct answer with no attempt at integration seen. If a candidate includes $+c$ in their final answer they do not get the final A1 mark.
		4	

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Question	Answer	Marks	Guidance
7(b)	$PE_{change} = \pm \left(12g \times 0.6 - 6.5g \times 0.6 \times \frac{5}{13} \right) [= \pm(72 - 15) = \pm 57]$	B1	Can be implied from equation with appropriate signs. Must have either $\frac{5}{13}$ or $\sin 23^\circ$... not just $\sin \alpha$.
	$KE_{change} = \pm \frac{1}{2} \times (12 + 6.5)v^2$	B1	Can be implied from equation with appropriate signs
	$WD_{friction} = \pm 0.4 \times 65 \times \frac{12}{13} \times 0.6 [= \pm 24 \times 0.6 = \pm 14.4]$	B1	Must have either $\frac{12}{13}$ or $\cos 23^\circ$... not just $\cos \alpha$
	$12g \times 0.6 - 6.5g \times 0.6 \times \frac{5}{13} - 0.4 \times 65 \times \frac{12}{13} \times 0.6 = 0.5 \times (12 + 6.5)v^2$ $72 - 15 - 14.4 = 0.5 \times (12 + 6.5)v^2$ $71 \times 0.6 = 0.5 \times (12 + 6.5)v^2$ $42.6 = 0.5 \times (12 + 6.5)v^2$	M1	Attempt at work energy equation with correct number of relevant terms; dimensionally correct. PE term must consist of two parts, with components as required. Allow sign errors. Do NOT allow sin/cos mix.
	$v = \sqrt{\frac{42.6}{9.25}} = 2.15$ Allow $v = \sqrt{\frac{852}{185}}$	A1	2.1460...
	Alternative method finding tension then using energy .		
	Use of Newton's second law for <i>A</i> AND <i>B</i> For <i>B</i> : $12g - T = 12a$ For <i>A</i> : $T - 6.5g \times \frac{5}{13} - 0.4 \times 6.5g \times \frac{12}{13} = 6.5a$	*M1	Must have correct number of relevant terms. Allow sign errors. Do not allow sin/cos mix. Forces must have components (or not) as required. Must have either $\frac{5}{13}$ or $\sin 23^\circ$... not just $\sin \alpha$ and likewise with $\cos \alpha$. Must not use their value of <i>T</i> from part (a).
	$T = \frac{2736}{37} = 73.945\dots$	A1	

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Question	Answer	Marks	Guidance
7(b)	Energy from tension = $\frac{2736}{37} \times 0.6$	DB1	
	For B: $\frac{1}{2} \times 12v^2 = 12g \times 0.6 - \frac{2736}{37} \times 0.6$ For A: $\frac{1}{2} \times 6.5v^2 + 6.5g \times \frac{5}{13} \times 0.6 + 0.4 \times 6.5g \times \frac{12}{13} \times 0.6 = 0.6 \times \frac{2736}{37}$	DM1	For either
	$v = \sqrt{\frac{42.6}{9.25}} = 2.15$ Allow $v = \sqrt{\frac{852}{185}}$	A1	If no marks scored allow SCB1 for work done $= \pm 0.4 \times 65 \times \frac{12}{13} \times 0.6$ [$= \pm 24 \times 0.6 = \pm 14.4$].
	Alternative method using energy but treating the particles separately		
	For B: $\frac{1}{2} \times 12v^2 = (12g - T) \times 0.6$	*B1	Must not use their value of T from part(a).
	Attempt to find an energy equation for particle A	*M1	Must have correct number of terms. Allow sign errors. Do NOT allow sin/cos mix. Must have either $\frac{5}{13}$ or $\sin 23^\circ$... not just $\sin \alpha$ and likewise with $\cos \alpha$. Must not use their value of T from part (a).
	$\frac{1}{2} \times 6.5v^2 = \left(T - 6.5g \times \frac{5}{13} - 0.4 \times 6.5g \times \frac{12}{13} \right) \times 0.6$	A1	Must have either $\frac{5}{13}$ or $\sin 23^\circ$... not just $\sin \alpha$ and likewise with $\cos \alpha$. Must not use their value of T from part (a).
	For attempt to solve to get to ' $v =$ ' or ' $v^2 =$ ' (by eliminating T)	DM1	

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Question	Answer	Marks	Guidance
7(b)	$v = \sqrt{\frac{42.6}{9.25}} = 2.15$ Allow $v = \sqrt{\frac{852}{185}}$	A1	If no solving seen allow M1A1 for correct answer or M1 if correct for their simultaneous equations. If no marks scored allow SCB1 for work done $= \pm 0.4 \times 65 \times \frac{12}{13} \times 0.6$ [$= \pm 24 \times 0.6 = \pm 14.4$].
Alternative method finding acceleration then forces then using energy.			
	Use of Newton's second law for system or for <i>A</i> AND <i>B</i> For system: $12g - 6.5g \times \frac{5}{13} - 0.4 \times 6.5g \times \frac{12}{13} = (12 + 6.5)a$ [$120 - 25 - 24 = 18.5a$] For <i>B</i> : $12g - T = 12a$ [$120 - T = 12a$] For <i>A</i> : $T - 6.5g \times \frac{5}{13} - 0.4 \times 6.5g \times \frac{12}{13} = 6.5a$ [$T - 25 - 24 = 6.5a$]	*M1	Must have correct number of relevant terms Allow sign errors. Do not allow sin/cos mix. Forces must have components (or not) as required. Must have either $\frac{5}{13}$ or sin 23... not just $\sin \alpha$ and likewise with $\cos \alpha$. Must not use their value of <i>T</i> from part (a).
	$a = \frac{142}{37} = 3.8378\dots$	A1	
	$F_B = 12 \times \frac{142}{37} = \frac{1704}{37}$ or $F_A = 6.5 \times \frac{142}{37} = \frac{923}{37}$ AND any one of [$EN_A = \frac{923}{37} \times 0.6$ or [$EN_B = \frac{1704}{37} \times 0.6$ or [$EN_{Total} = \left(\frac{1704}{37} + \frac{923}{37}\right) \times 0.6$	DB1	
	$\frac{1}{2} \times 6.5v^2 = \left(\frac{923}{37}\right) \times 0.6$ or $\frac{1}{2} \times 12v^2 = \left(\frac{1704}{37}\right) \times 0.6$ or $\frac{1}{2} \times (12 + 6.5)v^2 = \left(\frac{1704}{37} + \frac{923}{37}\right) \times 0.6$	DM1	

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Question	Answer	Marks	Guidance
7(b)	$v = \sqrt{\frac{42.6}{9.25}} = 2.15$ Allow $v = \sqrt{\frac{852}{185}}$	A1	If no marks scored allow SCB1 for work done $= \pm 0.4 \times 65 \times \frac{12}{13} \times 0.6$ [$= \pm 24 \times 0.6 = \pm 14.4$]
		5	