CAMBRIDGE
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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.

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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	$PE = \pm 25g \times 12\sin 8 \left[= \pm 3000\sin 8 = \pm 417.519\ldots\right]$	**B1**	If not seen separately allow **B1** for $\pm\left(25g\sin 8 \pm 50\right)\times 12$.
	$KE = \pm\frac{1}{2}\times 25\times 2.4^2 \left[= \pm 72\right]$	**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		
	$2.4^2 = 0^2 + 2a\times 12 \left[a = 0.24\right]$	***M1**	Or other suvat method using $u = 0, v = 2.4$ and $s = 12$.
	$F - 50 - 25g\sin 8 = 25\times \textit{their } a$ May have $\frac{W}{12}$ instead of F. May if correct see $F - 50 - 34.793\ldots = 6$ or $F = 90.793\ldots$	***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 $= \textit{their } F\times 12$	**DM1**	OE e.g. $F = \frac{W}{12}$ Dep on both **M** marks.
	Work done $= 1090$ J	**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 $= 31.894$ m s^{-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.
	$s=0.0306$ 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 $s=0.030649\ldots$ which gets full credit if correctly obtained.
	Alternative method using energy		
	PE – work done against friction $=\pm((1.5+0.005)g-25000)s[=\pm24984.95s]$	**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).
	$s=0.0306$ m	**A1**	0.030636983…
		3	

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Question	Answer	Marks	Guidance
3	$s_1 = 0.5\times30\times t_1 \quad s_3 = 0.5\times30\times t_3 \quad s_2 = 30\times T$ Allow $s_1 = \frac{900}{2a_1} \quad s_3 = \frac{900}{2a_3} \quad s_2 = 30\times T$	*M1	Use of suvat for displacement s= for at least two of the three or for $s_{1+3} = 0.5\times30\times(180-T)$. Must not use the same variable for all three.
	$4800 = 15t_1 + 30t_2 + 15t_3 \quad \left[=15(180-T)+30T\right]$	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 4200 m	B1FT	**FT** their T $30\times their\,T$
	Alternative method for question 3		
	Use of a trapezium (may be indicated by diagram) Or $0.5\times30\times(180+T)$	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).
	$0.5\times30\times(180+T)=4800$	B2	OE.
	$T = 140$	A1	Allow X or any other variable for time.
	Distance 4200 m	B1FT	**FT** their T $30\times their\,T$.
		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.
	$\left[X = R\cos\beta =\right] \pm\left(51\times\frac{8}{17} + 34\times\frac{8}{17} - 17\times\frac{15}{17}\right)\left[= \pm(24 + 16 - 15) = \pm 25\right]$	**A1**	Allow use of 62° or 28° or better [leading to ±24.8949… or better]. Note: consistent sin/cos mix leads to 67 which gets **M1A0A0**.
	$\left[Y = R\sin\beta =\right] \pm\left(51\times\frac{15}{17} - 34\times\frac{15}{17} - 17\times\frac{8}{17}\right)\left[= \pm(45 - 30 - 8) = \pm 7\right]$	**A1**	Allow use of 62° or 28° or better [leading to ±7.0290… or better]. Note: consistent sin/cos mix leads to -7 which gets **M1A0A0**.
	$R = \sqrt{25^2 + 7^2}$ Or $R = \frac{25}{(\cos their\ \beta)}$ or $\frac{7}{(\cos their\ \beta)}$ Or $R = \frac{7}{(\sin their\ \beta)}$ or $\frac{25}{(\sin their\ \beta)}$	**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 $\beta = \cos^{-1}\frac{25}{their\ R}$ or $\cos^{-1}\frac{7}{their\ R}$ or Or $\beta = \sin^{-1}\frac{7}{their\ R}$ or $\sin^{-1}\frac{25}{their\ R}$	**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.
	$R = 26[.0]$ N or $\sqrt{674}$ $\beta = 15.6°$ 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°, N74.4°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.
	$\pm(17-51\cos 33.855\ldots)[=\mp 25.3529\ldots]$	**A1**	
	$\pm(34-51\cos 56.144\ldots)[=\pm 5.5882\ldots]$	**A1**	
	$R = \sqrt{25.3529\ldots^2 + 5.5882\ldots^2}$	**M1**	Attempt to solve for R.
	$\beta = \tan^{-1}\frac{5.5882\ldots}{-25.3529\ldots} + \tan^{-1}\frac{8}{15}$	**M1**	OE. Attempt to solve for β.

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Question	Answer	Marks	Guidance
4(a)	$R = 26[.0]\text{N} \quad \beta = 15.6°$ 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 *their R*.
	$\frac{28000}{36} - \frac{24000}{32} = 1500 \times a$ or $777.777\ldots - 750 = 1500 \times a$	**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 *their* 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 $[s=]\int\left(4t^2-60t+225\right)\mathrm{d}t$	***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(a)	$T = mg$ or $T - mg = 0$	**B1**	
	$R = 6.5g \times \frac{12}{13}\left[= 60\right]$	**B1**	Allow $\cos 23$ or better but must have more than simply $\cos\alpha$. Must be identified as reaction here or when friction term is formed.
	$T - 6.5g \times \frac{5}{13} + F = 0$ or $T - 25 + F = 0$ Can instead use system equation $mg = 25 - F$ $T - 6.5g \times \frac{5}{13} - F = 0$ or $T - 25 - F = 0$ Can instead use system equation $mg = 25 + F$	***M1**	Resolving along the plane, either case to form an equation. Must be component of weight and g must be present. Allow any non-zero single term F. Allow any non-zero single term T in terms of mg. If either of the system equations seen, then first **B1** can be implied (even if friction or component of $6.5g$ missing). Allow sin/cos mix (need not be consistent) but must have more than simply $\sin\alpha$ and / or $\cos\alpha$ with $\alpha = 23$ or better.
		A1	For both correct. Must have more than simply $\sin\alpha$ and / or $\cos\alpha$ but $\alpha = 23$ or better.
	Use $F = 0.4R\left[= 24\right]$ to get an equation in m only	**DM1**	Where R is a component of weight.
	$m = 0.1$ or $m = 4.9$	**A1**	
	$0.1 \leqslant m \leqslant 4.9$ or $\{m \in \mathbb{R} : 0.1 \leqslant m \leqslant 4.9\}$ or $[0.1, 4.9]$	**A1**	
		7	

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Question	Answer	Marks	Guidance
7(b)	$PE_{change} = \pm\left(12g \times 0.6 - 6.5g \times 0.6 \times \frac{5}{13}\right)$ $\left[= \pm(72 - 15) = \pm 57\right]$	**B1**	Can be implied from equation with appropriate signs. Must have either $\frac{5}{13}$ or $\sin 23\ldots$ 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
	$WD_{friction} = \pm 0.4 \times 65 \times \frac{12}{13} \times 0.6$ $\left[= \pm 24 \times 0.6 = \pm 14.4\right]$	**B1**	Must have either $\frac{12}{13}$ or $\cos 23\ldots$ 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 A AND B For B: $12g - T = 12a$ For A: $T - 6.5g \times \frac{5}{13} - 0.4 \times 6.5g \times \frac{12}{13} = 6.5a$	***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 $\sin 23\ldots$ not just $\sin\alpha$ and likewise with $\cos\alpha$. Must not use their value of T from part **(a)**.
	$T = \frac{2736}{37} = 73.945\ldots$	**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 $= \pm 0.4 \times 65 \times \frac{12}{13} \times 0.6$ $\left[= \pm 24 \times 0.6 = \pm 14.4 \right]$.
	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 $\sin 23\ldots$ 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 $\sin 23\ldots$ 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 $=\pm 0.4\times 65\times\frac{12}{13}\times 0.6$ $\left[=\pm 24\times 0.6=\pm 14.4\right]$.
	Alternative method finding acceleration then forces then using energy.		
	Use of Newton's second law for system or for A AND B For system: $12g-6.5g\times\frac{5}{13}-0.4\times 6.5g\times\frac{12}{13}=(12+6.5)a$ $\left[120-25-24=18.5a\right]$ For B: $12g-T=12a$ $\left[120-T=12a\right]$ For A: $T-6.5g\times\frac{5}{13}-0.4\times 6.5g\times\frac{12}{13}=6.5a$ $\left[T-25-24=6.5a\right]$	***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 $\sin 23\ldots$ not just $\sin\alpha$ and likewise with $\cos\alpha$. Must not use their value of T from part **(a)**.
	$a=\frac{142}{37}=3.8378\ldots$	**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 $\left[EN_A=\right]\frac{923}{37}\times 0.6$ or $\left[EN_B=\right]\frac{1704}{37}\times 0.6$ or $\left[EN_{Total}=\right]\left(\frac{1704}{37}+\frac{923}{37}\right)\times 0.6$	**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 $= \pm 0.4 \times 65 \times \frac{12}{13} \times 0.6$ $\left[= \pm 24 \times 0.6 = \pm 14.4\right]$
		5	

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