CAMBRIDGE
International Education

Cambridge International AS & A Level

MATHEMATICS **9709/42**

Paper 4 Mechanics **May/June 2026**

MARK SCHEME

Maximum Mark: 50

Published

This mark scheme contains the instructions and marking guidance that our examiners used to mark candidate responses for this component.

Before they start marking, examiners complete a standardisation process. They review a range of candidate responses and discuss the mark scheme in detail to agree which answers can and cannot be accepted. Examiners award marks where it is clear that candidate responses have met the requirements of the mark scheme. These requirements may vary between different components or different versions of the same component, depending on the exact requirements of the question and the candidate responses seen during the standardisation process.

Sometimes, our mark schemes may allow marks to be awarded to responses which contain elements that are factually incorrect or for content not covered by the syllabus. We do this in response to the demands of a specific question to support candidates and make sure that our assessments are fair. However, these allowances should not be used as a guide for teaching and learning.

We cannot discuss the mark scheme with schools, and we recommend that schools read the mark scheme together with the assessment material and the Principal Examiner Report for Teachers.

General marking principles

All examiners must apply these marking principles when marking candidate responses.

1	Examiners must award marks for each response in line with: • the specific **content** defined in the mark scheme • the specific **skills** defined in the mark scheme or in the level descriptions • the **standard of response** required as exemplified by the standardisation scripts.
2	Examiners must award **whole marks** (not half marks, or other fractions).
3	Examiners must award marks **positively**. This means that: • marks are not deducted for errors or omissions • marks are awarded for correct/valid answers as defined in the mark scheme and also for **other valid answers** which go beyond the scope of the syllabus and mark scheme referring to your team leader as appropriate • the quality of spelling, punctuation and grammar are judged **only** when the mark scheme indicates that these features are **specifically assessed** in the question. However, the meaning of all responses must be unambiguous.
4	Examiners must **consistently** apply the requirements of the mark scheme and any rules for what to do when candidates have not followed instructions correctly.
5	Examiners must use the **full range of marks** defined in the mark scheme, unless limited by the quality of the candidate responses seen.
6	Examiners must award marks according to the mark scheme and **must not** award marks with grade thresholds or grade descriptions 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)
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

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.

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

Question	Answer	Marks	Guidance
1(a)	$\frac{P}{25} - 620 = 0$	**M1**	Attempt at N2L with use of $P = Fv$; correct number of terms, allow sign errors. OE.
	15 500 W or 15.5 kW	**A1**	Allow 15 500 without units or wrong units, but 15.5 must have correct units.
		2	
1(b)	$\frac{(their 15500) + 12000}{25} - 620 = 960a$ or $\frac{12000}{25} = 960a$ $[1100 - 620 = 960a]$ $[480 = 960a]$	**M1**	Attempt at N2L with use of $P = Fv$; correct number of relevant terms, allow sign errors condone 15.5 + 12 for 27 500
	0.5 ms^{-2}	**A1FT**	OE e.g. $\frac{480}{960}$. **FT** *their* 15500 from **1(a)**, where *their* $15500 > 3500$. $a = \frac{P - 3500}{24000}$.
		2	

Question	Answer	Marks	Guidance
2(a)	$2.5\times 3=(2.5+3.5)v$	**M1**	Use of CLM – allow a slip in one mass only – if correct then $v=1.25$.
	[Speed of C after impact with the wall is] 0.9375 or $\frac{15}{16}$ m s^{-1}	**A1**	Allow 0.938. Use of mg in momentum equation scores **M1A0** max.
		2	
2(b)	Times are $\frac{9}{their\,1.25}$ and $\frac{9}{their\,0.9375}$ $[=7.2\text{ and }9.6]$	**M1**	Correct method to find total required time or both times. Calculating (and using) acceleration is **M0.**
	16.8 s	**A1**	AWRT 16.8. Allow if used mg in momentum equation.
		2	

Question	Answer	Marks	Guidance
3(a)	**EITHER:** $0.3 = 0 + \frac{1}{2}a \times 0.4^2 \quad [\Rightarrow a = 3.75]$	**(*B1**	For a correct equation in a only, e.g. $s = ut + \frac{1}{2}at^2$ with $u = 0$, $s = 0.3$ and $t = 0.4$ or e.g. $0.3 = \frac{1}{2}(0 + v) \times 0.4$ and $1.5 = 0 + 0.4a$.
	Attempt at N2L for B **OR** Attempt at N2L for the system **AND** for A	***M1**	Correct number of terms and dimensionally consistent, allow sign errors and sin/cos mix, any force that needs resolving should be resolved. Allow with just a or possibly their incorrect a.
	$0.8g \sin 55 - T = 0.8 \times (their\ 3.75)$ **OR** $0.8g \sin 55 - F_A = (0.8 + 0.5) \times (their\ 3.75)$ **AND** $T - F_A = 0.5 \times (their\ 3.75)$	**DM1**	**Correct equation (no sin/cos mix)** for T following through their value of a. For reference $F_A = 1.678216354$.
	3.55 N	**A1)**	AWRT 3.55 (3.553216…).
	OR: **Alternative using energy on particle *B***		
	$0.3 = \frac{1}{2}(0 + v) \times 0.4 \quad [\Rightarrow v = 1.5]$	**(*B1**	For a correct equation in v only.
	Attempt at energy for B	***M1**	Correct number of terms, dimensionally correct, allow sign errors and sin/cos mix, any force that needs resolving should be resolved. Allow with just v or possibly their incorrect v.
	$\frac{1}{2} \times 0.8 \times (their\ 1.5)^2 + T \times 0.3 = 0.8g \sin 55 \times 0.3$	**DM1**	**Correct equation (no sin/cos mix)** for T following through their value of v.

Question	Answer	Marks	Guidance
3(a)	3.55 N	**A1)**	AWRT 3.55 (3.553216…).
	Available marks:	**4**	
3(b)	$(their\ 3.55) - F_A = 0.5 \times (their\ 3.75)$ **OR** $0.8g \sin 55 - F_A = (0.8 + 0.5) \times (their\ 3.75)$	**M1**	Attempt at N2L for A or for the system; correct number of terms and dimensionally consistent, allow sign errors – allow T and a. For reference $F_A = 1.678216354$.
	$(their\ 3.55) - \mu \times 0.5g = 0.5 \times (their\ 3.75)$ $[3.55 - 5\mu = 1.875]$ **OR** $0.8g \sin 55 - \mu \times 0.5g = (0.8 + 0.5) \times (their\ 3.75)$ $[6.5532\ldots - 5\mu = 4.875]$	**A1FT**	Correct equation for μ follow through their T and their $a \neq \pm g$ – must be using $0.5g$ for R.
	$\mu = 0.336$ or 0.335	**A1**	AWRT 0.336 or 0.335. 0.335643… if exact values used or 0.335 if using 3.55 for T.
		3	

Question	Answer	Marks	Guidance
3(c)	**EITHER:** Speed when string breaks is $v=(their\,3.75)\times 0.4$ $[v=1.5]$ OR $0.3=\frac{1}{2}(0+v)\times 0.4$ OR $v^2=0^2+2\times 0.3\times(their\,3.75)$	**(*B1FT**	A correct equation in v or v^2 when the string breaks following through their $a\neq\pm g$ from **3(a)**.
	Work done by frictional force is $\pm\frac{1}{2}\times 0.5\times(their\,1.5)^2$	**DM1**	Use of 'work done by frictional force = change in KE'. Complete method to find the work done by frictional force **after** the rope is removed ONLY, OR **M2** for $0.5\times their\,3.75\times 0.3$ (not embedded) OR **M2** for $(their\,3.553216-0.5g\times their\,0.33564)\times 0.3$ (not embedded) from $(T-F)\times 0.3$.
	0.5625 J or $\frac{9}{16}$ J	**A1)**	Allow ± 0.563, ± 0.562, -0.5625. **DO NOT ISW.**
	OR: **ALTERNATIVE FOR 3(c)**		
	Speed when string breaks is $v=(their\,3.75)\times 0.4$ $[\Rightarrow 1.5]$ OR $0.3=\frac{1}{2}(0+v)\times 0.4$ OR $v^2=0^2+2\times 0.3\times(their\,3.75)$	**(*B1FT**	A correct equation in v or v^2 when the string breaks following through their $a\neq\pm g$ from **3(a).**

Question	Answer	Marks	Guidance
3(c)	$-(\textit{their}\,0.335)\times 0.5g = 0.5a \Rightarrow a = -g\times(\textit{their}\,0.3356\ldots)$ $0^2 = 1.5^2 + 2(-3.35...)s \Rightarrow s = 0.335...$ $0^2 = (\textit{their}\,1.5)^2 + 2\times(-g\times(\textit{their}\,0.335))s \quad [\Rightarrow s = 0.335\ldots]$ Work done by frictional force is $0.3356\ldots\times 0.5g\times 0.335$	**DM1**	Complete method to find the work done by frictional force **after** the rope is removed ONLY. E.g. $(0.3+0.3356\ldots)\times 0.5g\times 0.335$ is **M0**
	0.5625 J or $\frac{9}{16}$ J	**A1)**	Allow ± 0.563, ± 0.562, -0.5625. **DO NOT ISW.**
	Available marks:	**3**	

Question	Answer	Marks	Guidance
4(a)	$R = mg \times \frac{3}{5}$ $[= 6m]$	**B1**	Correct expression for the normal contact force – allow 53 or better for angle. Allow $R = mg\cos\left(\tan^{-1}\left(\frac{4}{3}\right)\right)$. **B1** if we just see $R = 6m$ or $R = mg\cos\theta = 6m$.
	$F = \frac{1}{3} \times \frac{3}{5} mg$ $[= 2m]$	***M1**	Use of $F = \frac{1}{3}R$ where R is a component of weight. Allow if R comes from value of $\cos\theta$ or $\sin\theta$ not seen substituted. If m cancelled in an energy attempt, then **B1M1** is available. Allow $F = \frac{1}{3}mg\cos\left(\tan^{-1}\left(\frac{4}{3}\right)\right)$ or $F = \frac{1}{3}mg\sin\left(\tan^{-1}\left(\frac{4}{3}\right)\right)$. If $F = 2m$ with no working seen then **B1M1.**
	$0 - \frac{1}{2} \times m \times 4^2 = -mg \times d \times \frac{4}{5} - \frac{1}{3} \times \frac{3}{5} mg \times d$ $[-8m = -8md - 2md]$	**DM1**	Use of work-energy principle; 3 terms, dimensionally consistent. **M0** if using $\pm mgd$ for PE term (where d is the distance between A and B). **As a minimum** $-8 = -8\boldsymbol{d} - 2\boldsymbol{d}$. Allow sin/cos mix, allow sign errors, allow 53 or better for angle. If m cancelled before any substitution, then do allow once the substitution takes place so may see $0 - \frac{1}{2} \times 4^2 = -g \times d \times \frac{4}{5} - \frac{1}{3} \times \frac{3}{5} g \times d$ and scores **B1M1M1.**

Question	Answer	Marks	Guidance
4(a)	$d\left[=\dfrac{8m}{8m+2m}\right]=0.8$	**A1**	**AG.** Allow $\frac{8}{10}$, $\frac{4}{5}$. **A0** if any error seen. Allow $\dfrac{8m}{mg\sin 53(.13\ldots)+\frac{1}{3}mg\cos 53(.13\ldots)}=0.8(0\ldots)$. Do not allow $\dfrac{8m}{mg\sin 53(.13\ldots)+\frac{1}{3}mg\cos 53(.13\ldots)}=0.8006\approx 0.8$ **Setting m to a value without justification or omitting m is 0 marks.**
		4	

Question	Answer	Marks	Guidance
4(b)	**EITHER:** Time up the plane is 0.4	**(B1**	Allow for a correct equation in t only, e.g. $0.8=\frac{1}{2}(4+0)t$.
	$(m)a=(m)g\times\frac{4}{5}-(m)g\times\frac{1}{3}\times\frac{3}{5}$	***M1**	Use of N2L down the plane (allow consistent absence of m); correct number of relevant terms, dimensionally consistent, do not allow sign errors but allow sin/cos mix, allow 53 or better for angle. Allow $\sin\left(\tan^{-1}\left(\frac{4}{3}\right)\right)$ and $\cos\left(\tan^{-1}\left(\frac{4}{3}\right)\right)$.
	$a=6$	**A1**	Allow AWRT 6.0.
	$0.8=0+\frac{1}{2}\times(their\,6)\times t^2$	**DM1**	Using constant acceleration formula(e) to get an equation in t ONLY with $u = 0$, $s = 0.8$ and their a, where t is the time down the plane. May be using their v which must have come from a correct method. Using $a=\pm10$ for acceleration down the plane is **M0.** For reference $t=0.5163\ldots=\frac{2\sqrt{15}}{15}$.
	0.916 s	**A1)**	AWRT 0.916 (0.916397…). Allow exact $\frac{6+2\sqrt{15}}{15}$.

Question	Answer	Marks	Guidance
4(b)	**OR:** **Alternative using energy**		
	Time up the plane is 0.4	**(B1**	Allow for a correct equation in t only, e.g. $0.8=\frac{1}{2}(4+0)t$.
	Attempt at energy equation $10m\times0.8\times\frac{4}{5}=\frac{1}{3}\times\frac{3}{5}mg\times0.8+\frac{1}{2}mv^2$ **OR** $2\times\left(mg\times\frac{1}{3}\times\frac{3}{5}\times0.8\right)=\frac{1}{2}m\times4^2-\frac{1}{2}mv^2$	***M1**	Use of work-energy principle; correct number of terms, dimensionally consistent, allow sign errors and sin/cos mix, allow 53 or better for angle. Allow $\sin\left(\tan^{-1}\left(\frac{4}{3}\right)\right)$ and $\cos\left(\tan^{-1}\left(\frac{4}{3}\right)\right)$.
	$v=\sqrt{9.6}=\frac{4\sqrt{15}}{5}=3.098\ldots..$	**A1**	Allow $v^2=9.6$ (or AWRT). Allow AWRT 3.1 for v .
	$0.8=\frac{1}{2}\left(0+\sqrt{9.6}\right)t$	**DM1**	Using constant acceleration formula(e) to get an equation in t ONLY with u = 0, s = 0.8 and their v , where t is the time down the plane. May be using their a which must have come from a correct method. For reference $t=0.5163\ldots=\frac{2\sqrt{15}}{15}$.
	0.916 s	**A1)**	AWRT 0.916 (0.916397…). Allow exact $\frac{6+2\sqrt{15}}{15}$.
	DO NOT ALLOW MISREAD OF ONE FOR THE TIME DIFFERENCE		
	Available marks:	**5**	

Question	Answer	Marks	Guidance
5	**EITHER:** For P: $[h=]\pm\left(\frac{1}{2}gt_P^2\right)$	**(*B1**	Allow if $t_P = t_Q \pm 1$.
	For Q: $[h=]\pm\left(18t_Q+\frac{1}{2}gt_Q^2\right)$	***B1**	Allow if $t_Q = t_P \pm 1$. **B1B1** if using different variables for the 2 times but if using the same variable the difference between them should be 1. If using same t allow **B1B1** if subsequent working shows that the t's are not the same.
	$\frac{1}{2}g\left(1+t_Q\right)^2=18t_Q+\frac{1}{2}gt_Q^2$ **OR** $\frac{1}{2}gt_P^2=18\left(t_P-1\right)+\frac{1}{2}g\left(t_P-1\right)^2$	***DM1**	Using $t_Q = t_P \pm 1$ to obtain an equation in one time only which would lead to a linear equation in t, so must have same sign for the squared term. Dependent on both **B** marks.
	$\frac{1}{2}g\left(1+2t_Q+t_Q^2\right)=18t_Q+\frac{1}{2}gt_Q^2 \Rightarrow 8t_Q=5 \Rightarrow t_Q=\ldots$ OR $\frac{1}{2}gt_P^2=18\left(t_P-1\right)+\frac{1}{2}g\left(t_P^2-2t_P+1\right) \Rightarrow 8t_P=13 \Rightarrow t_P=\ldots$	**DM1**	Expand all brackets correctly and solve remaining **linear** equation to find either time. Their linear equation must lead to a positive t. Dependent on all previous marks.
	$t_Q=0.625 \text{ or } \frac{5}{8}$ or $t_P=1.625 \text{ or } \frac{13}{8}$	**A1**	Either correct time.
	$h=13.2$	**A1)**	AWRT 13.2 (13.203125) or $\frac{845}{64}$.

Question	Answer	Marks	Guidance
5	**OR:** **ALTERNATIVE FOR Q5** **DO NOT ALLOW MISREAD OF ONE FOR THE TIME DIFFERENCE**		
	For P: $v = 0 + g \times 1 [= 10]$ **AND** $s_P = \pm\left((their 10)t + \frac{1}{2}gt^2\right)$	**(*B1**	
	For Q: $s_Q = \pm\left(18t + \frac{1}{2}gt^2\right)$	***B1**	Must be the same t.
	For P: $s = 0 + \frac{1}{2}g \times 1^2 [= 5]$ **AND** $(their 5) + (their 10)t + \frac{1}{2}gt^2 = 18t + \frac{1}{2}gt^2$	***DM1**	Use $s_P \pm (their 5) = s_Q$ to obtain an equation in t only which would lead to a linear equation in t, so must have same sign for the squared term. Dependent on both **B** marks.
	$8t = 5 \Rightarrow t = \ldots$	**DM1**	Solve remaining **linear** equation to find t. Their linear equation must lead to a positive t. Dependent on all previous marks.
	$t = 0.625$ or $\frac{5}{8}$	**A1**	
	$h = 13.2$	**A1)**	AWRT 13.2 (13.203125) or $\frac{845}{64}$.

Question	Answer	Marks	Guidance
5	**OR:** **SECOND ALTERNATIVE FOR Q5** **DO NOT ALLOW MISREAD OF ONE FOR THE TIME DIFFERENCE**		
	For P: $[h=]\pm\left(\frac{1}{2}gt_P{}^2\right)$	**(*B1**	Allow if $t_P = t_Q \pm 1$.
	For Q: $[h=]\pm\left(18t_Q+\frac{1}{2}gt_Q^2\right)$	***B1**	Allow if $t_Q = t_P \pm 1$. **B1B1** if using different variables for the 2 times but if using the same variable the difference between them must be 1. If using same t allow **B1B1** if subsequent working shows that the t's are not the same.
	$t_P=\sqrt{\frac{2h}{g}}$ **AND** $h=18\left(\sqrt{\frac{2h}{g}}-1\right)+\frac{1}{2}g\left(\sqrt{\frac{2h}{g}}-1\right)^2$	***DM1**	Make t_P the subject, substitute into the other equation and using $t_Q = t_P \pm 1$ to obtain an equation in h only which would lead to a linear equation in $\sqrt{h}$, so no terms in h. Dependent on both **B** marks.
	$h=18\left(\sqrt{\frac{2h}{g}}-1\right)+\frac{1}{2}g\left(\frac{2h}{g}-2\sqrt{\frac{2h}{g}}+1\right) \Rightarrow 0=8\sqrt{\frac{h}{5}}-13 \Rightarrow h=\ldots$	**DM1**	Expand all brackets correctly and solve remaining **linear** equation to find h. Their linear equation must lead to a positive $\sqrt{h}$. Dependent on all previous marks.
	$h=13.2$	**A2)**	AWRT 13.2 (13.203125) or $\frac{845}{64}$.
	Available marks:	**6**	

Question	Answer	Marks	Guidance
6(a)	Attempt to apply N2L either horizontally or vertically to form an equation	*M1	Correct number of terms, allow sign errors and sin/cos mix. May see use of m instead of W. Values(s) of $\sin\theta/\cos\theta$ or θ must be substituted. Allow sin/cos mix, allow 23 or better for angle.
	$26\times\frac{12}{13}-F=\frac{W}{g}\times1.5$ $\left[24-F=\frac{3W}{20}\right]$	A1	Allow 23 or better for angle ($\theta=22.6198\ldots$). Allow *their* F. Allow e.g. $26\times\frac{12}{13}-F=m\times1.5$, $26\times\cos\left(\sin^{-1}\left(\frac{5}{13}\right)\right)-F=\frac{W}{g}\times1.5$.
	$26\times\frac{5}{13}+R=W$ $[10+R=W]$	A1	Allow 23 or better for angle ($\theta=22.6198\ldots$). Allow $26\times\frac{5}{13}+R=mg$.
	$26\times\frac{12}{13}-0.25\times\left(W-26\times\frac{5}{13}\right)=\frac{W}{g}\times1.5$ **OR** $26\times\frac{12}{13}-0.25\times\left(mg-26\times\frac{5}{13}\right)=m\times1.5$ **OR** $26\times\frac{12}{13}-0.25R=\frac{10+R}{g}\times1.5$	DM1	Use of $F=0.25R$ with correct number of relevant terms to obtain an equation in W (or m) or R or F only. For reference $R=56.25$, $F=14.0625$, $m=6.625$.
	$\left[\begin{array}{l}24-0.25W+2.5=0.15W\\ OR\,24-2.5m+2.5=1.5m\\ OR\,24-0.25R=1.5+0.15R\end{array}\right]$ $W=66.25$ or $\frac{265}{4}$	A1	Allow 66.3, 66.2. AWRT 66.25.
		5	

Question	Answer	Marks	Guidance
6(b)	**EITHER:** $\left(\frac{W}{g}\right)a = -0.25 \times W$ **OR** $a = -0.25g$	**(*B1**	Allow $+0.25 \times \left(\frac{W}{g}\right)g$. Allow with their incorrect W. For reference $a = \pm 2.5$. AWRT ± 2.5 WWW. **BEWARE** Using W as mass gets acceleration from wrong work, award **B0M0A0.**
	$0 = 8^2 + 2 \times -2.5 \times AB$ $0 = 8^2 + 2 \times (-0.25 \times g) \times AB$	**DM1**	Use of $v^2 = u^2 + 2as$ with a negative acceleration $\neq -1.5, -g$ and $v = 0, u = 8$.
	12.8	**A1)**	Allow 12.8 from incorrect W (as independent of this value) or just using W.
	OR: **Alternative for 6(b)**		
	$0.25 \times (their\ 66.25) \times AB$	**(*B1FT**	Use of $F = 0.25R$ with their W only for R from **6(a)**, allow $\pm$. For reference $F = 16.5625$ or $\frac{265}{16}$. Allow with their incorrect W.
	$0 - \frac{1}{2} \times \frac{(their\ 66.25)}{g} \times 8^2 = -0.25 \times (their\ 66.25) \times AB$	**DM1**	Work-energy principle; correct number of terms, allow sign errors but must be dimensionally consistent.
	12.8	**A1)**	Allow 12.8 from incorrect W (as independent of this value) or just using W.
	Available marks:	**3**	

Question	Answer	Marks	Guidance
7(a)	$v = k_1(4t+11)^{\frac{1}{2}} - \frac{1}{4}(2t+1)^2 + k_2 \Rightarrow \left[\frac{\mathrm{d}v}{\mathrm{d}t}\right] = \ldots$	***M1**	Attempt to differentiate v; of the form $A(4t+11)^{-\frac{1}{2}} + Bt + C$ (for non-zero A, B and C). Condone k_2 appearing in their C.
	$[a =]\frac{1}{2}k_1(4t+11)^{\frac{1}{2}-1} \times 4 - 2 \times \frac{1}{4} \times (2t+1)^{2-1} \times 2$ $\left[= 2k_1(4t+11)^{-\frac{1}{2}} - (2t+1)\right]$	**A1**	Correct expression - allow un-simplified.
	$2k_1(4\times1.25+11)^{-\frac{1}{2}} - (2\times1.25+1) = -0.5$	**DM1**	Substitute $t = 1.25$, $a = \pm 0.5$ into their differentiated expression to get an equation in k_1 only. Condone poor simplification before substitution.
	$k_1 = 6$	**A1**	Condone $k_1 = 8$ **BUT** only from using $a = 0.5$.
		4	

Question	Answer	Marks	Guidance
7(b)	$(their\,6)\times(4\times3.5+11)^{\frac{1}{2}}-\frac{1}{4}(2\times3.5+1)^2+k_2=0$	(*M1	Use $v=0$ and $t=3.5$ in the correct given expression (no misreads) for v to form an equation in k_2 only – using their k_1 (if correct then $k_2=-14$).
	Attempt to integrate $v\left[=k_1(4t+11)^{\frac{1}{2}}-\frac{1}{4}(2t+1)^2+k_2\right]$	*M1	Must be of the form $D(4t+11)^{\frac{3}{2}}+E(2t+1)^3+Ft$ (for non-zero D, E and F) OR of the form $D(4t+11)^{\frac{3}{2}}+Gt^3+Ht^2+It$ (for non-zero D, G, H and I).
	$[s=]\frac{k_1(4t+11)^{1+\frac{1}{2}}}{4\times\left(1+\frac{1}{2}\right)}-\frac{(2t+1)^{2+1}}{4\times2\times(2+1)}+k_2t\ (+c)\left[=(4t+11)^{\frac{3}{2}}-\frac{(2t+1)^3}{24}-14t(+c)\right]$	A1FT	Follow through their **non-zero** values of k_1, k_2 **if** substituted but do not need to be substituted – allow un-simplified. **Note M0M1A1FT** is possible.
	$[s=]\left[(4t+11)^{\frac{3}{2}}-\frac{(2t+1)^3}{24}-14t\right]_0^1=\left[15^{\frac{3}{2}}-\frac{3^3}{24}-14\right]-\left[11^{\frac{3}{2}}-\frac{1}{24}\right]$	DM1	Use of correct limits correctly in their integrated expression - condone incorrect simplification of their integrated expression, but do not condone a miscopy. Must be using non-zero values of k_1 and k_2. Must check their values of $F(1)-F(0)$ if substitution not seen, OR calculate $+c$ using $s=0$ when $t=0$ (if correct $c=-36.4412\ldots$) **AND** substituting $t=1$ into their integrated expression. – **dependent on all previous M marks.**

Question	Answer	Marks	Guidance
7(b)	$[42.96975\ldots - 36.4412\ldots =]$ 6.53 m	**A1)**	AWRT 6.53 (6.528544…) WWW. Must follow their limits if seen substituted. **SC** if no integration seen then **B1** for 6.53, hence **M1B1** max 2 marks out of 5.
	OR: **SC for candidates using $k_1 = 8$ (obtained from using $a = 0.5$)**		
	$(their\,8)\times(4\times3.5+11)^{\frac{1}{2}} - \frac{1}{4}(2\times3.5+1)^2 + k_2 = 0$	**(*M1**	Use $v = 0$ and $t = 3.5$ in the correct given expression (no misreads) for v to form an equation in k_2 only – using their k_1. (if correct then $k_2 = -24$).
	Attempt to integrate v	***M1**	Must be of the form $D(4t+11)^{\frac{3}{2}} + E(2t+1)^3 + Ft$ (for non-zero D, E and F), OR of the form $D(4t+11)^{\frac{3}{2}} + Gt^3 + Ht^2 + It$ (for non-zero D, G, H and I).
	$[s =]\frac{k_1(4t+11)^{\frac{3}{2}}}{4\times\frac{3}{2}} - \frac{(2t+1)^3}{4\times2\times3} + k_2 t\ (+c)$	**A1FT**	Follow through their values of k_1, k_2 if substituted (but both constants must be non-zero if substituted) – allow un-simplified. **Note M0M1A1FT** is possible.

Question	Answer	Marks	Guidance
7(b)	$[s=]\left[\frac{8}{6}(4t+11)^{\frac{3}{2}}-\frac{(2t+1)^3}{24}-24t\right]_0^1=\left[\frac{8}{6}\times15^{\frac{3}{2}}-\frac{3^3}{24}-24\right]-\left[\frac{8}{6}\times11^{\frac{3}{2}}-\frac{1}{24}\right]$	**DM1**	Use of correct limits correctly in their integrated expression - condone incorrect simplification of their integrated expression, but do not condone a miscopy. Must be using non-zero values of k_1 and k_2. Must check their values of $\mathrm{F}(1)-\mathrm{F}(0)$, if substitution not seen OR calculate $+c$ using $s=0$ when $t=0$ (if correct $c=-48.60216\ldots$) **AND** substituting $t=1$ into their integrated expression. – **dependent on all previous M marks.**
	$[52.33466\ldots-48.60216\ldots=]$ 3.73 m	**A1)**	AWRT 3.73 (3.732503…) WWW. Must follow their limits if seen substituted. **SC** if no integration seen then **B1** for 3.73, hence **M1B1** max 2 marks out of 5.
		5	