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MATHEMATICS **9709/42**

Paper 4 Mechanics **October/November 2024**

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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Mark Scheme Notes

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

Types of mark

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

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

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

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

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

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

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Abbreviations

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

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Question	Answer	Marks	Guidance
1(a)	Use of $v = u + at$ or use of acceleration is gradient of the line	**M1**	Use $v = 0$, $a = \pm\frac{5}{3}$ and $t = 10 - 4\left[= 6\right]$. $0 = V - \frac{5}{3} \times (10 - 4)$ OR $\frac{0 - V}{10 - 4} = -\frac{5}{3}$ OR $\frac{V - 0}{4 - 0} = \frac{5}{2}$.
	$V = 10$	**A1**	Make sure that 10 comes from a correct initial equation or equivalent, if not then A0, e.g. $\frac{0 - V}{10 - 4} = \frac{5}{3}$ leading to $V = 10$ is M1A0.
		2	

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Question	Answer	Marks	Guidance
1(b)	Distance in first 10 seconds $=\frac{1}{2}\times 10\times their\left\|V\right\|$	**B1FT**	SOI OE, e.g. $\frac{1}{2}\times 4\times their\ \left\|V\right\|+\frac{1}{2}\times(10-4)\times their\left\|V\right\|$ If correct distance is 50 m.
	$\frac{1}{2}\times(T-10)\times 3+\frac{1}{2}\times 10\times their\left\|V\right\|=68$ OR $\frac{1}{2}\times(T-10)\times 3+\frac{1}{2}\times 4\times their\left\|V\right\|+\frac{1}{2}\times(10-4)\times their\left\|V\right\|=68$	**M1**	Use distance (68) is total area under graph. Their 50 must be from $5\times their\left\|V\right\|$. Allow with -3. Allow $\frac{1}{2}\times X\times 3+\frac{1}{2}\times 10\times their\left\|V\right\|=68$ and use of $T=X+10$.
	$T=22$	**A1**	WWW Be aware that $V=10$ from wrong work in **(a)** can be awarded maximum of B1M1A0.
	Special Case for assumption of isosceles triangle for $t=10$ to $t=T$:		
	Distance in first 10 seconds $=\frac{1}{2}\times 10\times their\left\|V\right\|$	**B1FT**	SOI OE, e.g. $\frac{1}{2}\times 4\times their\ \left\|V\right\|+\frac{1}{2}\times(10-4)\times their\left\|V\right\|$. If correct distance is 50 m.
	$\left[\frac{1}{2}\times\left(\frac{T-10}{2}\right)\times 3=\frac{1}{2}\times(68-50)\rightarrow\right]T=22$	**B1**	WWW
	Special Case for assumption that particle returns to *O*:		
	$\left[\frac{1}{2}\times(T-10)\times 3=\frac{1}{2}\times 68\rightarrow\right]T=\frac{98}{3}$ or 32.7	**B1**	32.66666. AWRT 32.7.
		3	

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Question	Answer	Marks	Guidance
2	Change in PE = $\pm 20g\sin 30\times 2\ [=\pm 200]$	**B1**	
	$\pm\frac{1}{2}\times 20v^2 \quad [=\pm 10v^2]$ $\pm\frac{1}{2}\times 20\times 5^2 \ [=\pm 250]$	**B1**	For either expression. Do not allow $\frac{1}{2}\times 20(v-5)^2$.
	$\frac{1}{2}\times 20v^2-\frac{1}{2}\times 20\times 5^2=20g\sin 30\times 2-50$ $[10v^2-250=200-50]$	**M1**	Attempt at work energy equation; 4 terms; dimensionally correct; allow sign errors; PE term must include a component (allow sin/cos mix). Do not allow with $\frac{1}{2}\times 20(v-5)^2$ for KE.
	Speed = $6.32\,\text{ms}^{-1}$ OR $\sqrt{40}\ \text{ms}^{-1}$	**A1**	OE, e.g. $2\sqrt{10}$. 6.324555…. AWRT 6.32.
	Special case for assumption of constant resistance force:		
	$20a=20g\sin 30-\frac{50}{2}\ [\rightarrow a=3.75]$	**B1**	
	$v^2=5^2+2\times 2\times 3.75\Rightarrow v=6.32\ \text{ms}^{-1}$ OR $\sqrt{40}\ \text{ms}^{-1}$	**B1**	OE, e.g. $2\sqrt{10}$. 6.324555… AWRT 6.32.
		4	

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Question	Answer	Marks	Guidance
3(a)	[Peddling force $= PF =$] $\frac{250}{5}$	**B1**	For use of power $= Fv$ e.g. $5 \times PF = 250$.
	their $PF - R = 90 \times 0.1$	**M1**	Using their $PF \neq 250$. 3 terms; allow sign errors. Dimensionally correct.
	Resistance $= 41\,\text{N}$	**A1**	
		3	
3(b)	$\frac{250}{v} - \textit{their}\,41 - 90g\sin 2 = 0$	**M1**	For attempt at resolving up the hill; 3 terms; allow sign errors; Must be a component of weight (NOT mass) but allow sin/cos mix; allow use of *their* 41. Dimensionally correct. Oe eg $v = \frac{250}{\textit{their}\,41 + 90g\sin 2}$.
	Steady speed = 3.45 m s^{-1}	**A1**	3.45258… AWRT 3.45.
		2	

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Question	Answer	Marks	Guidance
4(a)	$T_{AB}\sin 45 = 0.2g\cos 45$ OR $\tan 45 = \frac{T_{AB}}{0.2g}$ OR $\tan 45 = \frac{0.2g}{T_{AB}}$ OR $T_{AB} = T_{AP}\cos 45$ **and** $T_{AP}\sin 45 = 0.2g$	***B1**	BOD for using $\sin 45$ instead of $\cos 45$, particularly if using wrong components in **(b).**
	$T_{AB} = 2$ N	**DB1**	Condone $T_{AB} = 0.2g$ (with or without working) for full marks. WWW. DO NOT ISW**.**
	ALTERNATIVE for 4(a) using LAMI's THEOREM:		
	$\frac{T_{AB}}{\sin 135} = \frac{0.2g}{\sin 135}$	**B1**	
	$T_{AB} = 2$ N	**B1**	Condone $T_{AB} = 0.2g$ (with or without working) for full marks. WWW. DO NOT ISW.
		2	

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Question	Answer	Marks	Guidance
4(b)	$T_{BQ}\cos\theta - their\,T_{AB} = 0$ $T_{BQ}\sin\theta - 0.1g = 0$	***M1**	For resolving either horizontally OR vertically; 2 terms; allow sin/cos mix; allow their T_{AB}; M0 for any use of $T_{AB} = T_{BQ} = T_{AP}$.
		A1FT	For both. FT their T_{AB} ONLY; $T_{AB} \neq T_{BQ}$. Sight of $\left(their\,T_{AB}\right)\tan\theta = 0.1g$ is M1 only without seeing an equation for T_{BQ}.
	$\theta = \tan^{-1}\left(\dfrac{0.1g}{their\,T_{AB}}\right)$ or $T_{BQ} = \sqrt{\left(0.1g\right)^2 + \left(their\,T_{AB}\right)^2}$	**DM1**	Solve for θ or solve for T_{BQ} from equations with the correct number of relevant terms. Using their T_{AB}.
	$\theta = 26.6$ AND $T_{BQ} = \sqrt{5}$ or 2.24	**A1**	$\theta = 26.56505\ldots$ $T_{BQ} = 2.236067\ldots$ AWRT 26.6 and 2.24.
	FIRST ALTERNATIVE for 4(b):		
	$T_{BQ} = \left(their\,T_{AB}\right)\cos\theta + 0.1g\sin\theta$ $\left(their\,T_{AB}\right)\sin\theta = 0.1g\cos\theta$	**M1**	For resolving either parallel to *BQ* or perpendicular to *BQ*; 2 terms; allow sign errors on 3 term equation only; allow sin/cos mix; allow their T_{AB}. Sight of $\left(their\,T_{AB}\right)\tan\theta = 0.1g$ is M1 only without seeing an equation for T_{BQ}. M0 for any use of $T_{AB} = T_{BQ} = T_{AP}$.
		A1FT	For both. FT their T_{AB} ONLY; $T_{AB} \neq T_{BQ}$.
	$\theta = \tan^{-1}\left(\dfrac{0.1g}{\left(their\,T_{AB}\right)}\right)$	**DM1**	Solve for θ (or solve for T_{BQ}) from equations with the correct number of relevant terms. Using their T_{AB}.

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Question	Answer	Marks	Guidance
4(b)	$\theta = 26.6$ AND $T_{BQ} = \sqrt{5}$ or 2.24	**A1**	$\theta = 26.56505\ldots$ $T_{BQ} = 2.236067\ldots$ AWRT 26.6 and 2.24.
	SECOND ALTERNATIVE for 4(b) using triangle of forces:		
	$T_{BQ}^2 = (0.1g)^2 + (their\ T_{AB})^2$ OR $0.1g = T_{BQ}\sin(\theta)$ OR $(their\ T_{AB}) = T_{BQ}\cos(\theta)$	**M1**	Using their T_{AB} ONLY; M0 for any use of $T_{AB} = T_{BQ} = T_{AP}$.
		A1FT	For any 2 equations. FT their T_{AB} ONLY; $T_{AB} \neq T_{BQ}$. Sight of $(their\ T_{AB})\tan\theta = 0.1g$ is M1 only without seeing an equation for T_{BQ}.
	Solve for T_{BQ} or θ E.g. $T_{BQ} = \sqrt{(0.1g)^2 + (their\ T_{AB})^2}$ $\theta = \tan^{-1}\left(\frac{0.1g}{their\ T_{AB}}\right)$	**DM1**	Solve for θ or solve for T_{BQ} from equations with the correct number of relevant terms. Using their T_{AB}.
	$\theta = 26.6$ AND $T_{BQ} = \sqrt{5}$ or 2.24	**A1**	$\theta = 26.56505\ldots$ $T_{BQ} = 2.236067\ldots$ AWRT 26.6 and 2.24.
	THIRD ALTERNATIVE for 4(b) using LAMI's THEOREM:		
		***M1**	For any 2 fractions correct; M0 for any use of $T_{AB} = T_{BQ} = T_{AP}$.

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Question	Answer	Marks	Guidance
	$\frac{T_{BQ}}{\sin 90} = \frac{0.1g}{\sin(180-\theta)} = \frac{their\ T_{AB}}{\sin(90+\theta)}$ OR $\frac{T_{BQ}}{\sin 90} = \frac{0.1g}{\sin\theta} = \frac{their\ T_{AB}}{\cos\theta}$	**A1FT**	For all 3 fractions correct. FT their T_{AB} ONLY. Sight of $(their\ T_{AB})\tan\theta = 0.1g$ is M1 only without seeing an equation for T_{BQ}.
4(b)	$\theta = \tan^{-1}\left(\frac{0.1g}{their\ T_{AB}}\right)$	**DM1**	Solve for θ.
	$\theta = 26.6$ AND $T_{BQ} = \sqrt{5}$ or 2.24	**A1**	$\theta = 26.56505\ldots$ $T_{BQ} = 2.236067\ldots$ AWRT 26.6 and 2.24.
	FOURTH ALTERNATIVE for 4(b) for resolving on the whole system:		
	$T_{BQ}\sin\theta + (their\ T_{AP})\sin 45 = 0.2g + 0.1g$ $T_{BQ}\cos\theta = (their\ T_{AP})\cos 45$	**M1**	For resolving either horizontally or vertically on the whole system; using $their\ T_{AP}$. M0 for any use of $T_{AB} = T_{BQ} = T_{AP}$. If T_{AP} not found in part **(a)**, must have either $T_{AP}\sin 45 = 0.2g$ or $(their\ T_{AB}) = T_{AP}\cos 45$. Correct number of terms; allow sign errors on the 4 term equation ONLY; allow sin/cos mix.
		A1FT	Both equations correct. May see $T_{BQ}\sin\theta = 1$ and $T_{BQ}\cos\theta = 2$. Sight of $(their\ T_{AB})\tan\theta = 0.1g$ is M1 only without seeing an equation for T_{BQ}.

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Question	Answer	Marks	Guidance
	$\theta = \tan^{-1}\left(\dfrac{0.1g + 0.2g - (their\ T_{AP})\sin 45}{(their\ T_{AP})\cos 45}\right)$ or $T_{BQ} = \sqrt{(0.1g + 0.2g - (their\ T_{AP})\sin 45)^2 + ((their\ T_{AP})\cos 45)^2}$	**DM1**	Solve for θ or solve for T_{BQ} from equations with the correct number of relevant terms. Using their T_{AP}.
	$\theta = 26.6$ AND $T_{BQ} = \sqrt{5}$ or 2.24	**A1**	$\theta = 26.56505\ldots$ $T_{BQ} = 2.236067\ldots$ AWRT 26.6 and 2.24.
		4	

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Question	Answer	Marks	Guidance
5(a)	$[s_P \text{ up} =] \pm\left(2t - \frac{1}{2}gt^2\right)$ **OR** $\left[s_Q \text{ down} =\right] \pm \frac{1}{2}gt^2$	**M1**	For use of $s = ut + \frac{1}{2}at^2$ at least once with $a = \pm g$ and $u = 0$ or $u = \pm 2$. Seen anywhere.
	$2t - \frac{1}{2}gt^2 + \frac{1}{2}gt^2 = 2 - 1 \left[\Rightarrow t = \frac{1}{2}\right]$	**M1**	Use $s_P + s_Q = \pm(2-1)$ OR ± 1 ONLY with s_P and s_Q of the correct form
	$v_P = 2 - \frac{1}{2}g = -3 \text{ ms}^{-1}$ so speed $= 3 \text{ ms}^{-1}$	**A1**	Must be positive.
	$v_Q = -\frac{1}{2}g = -5 \text{ ms}^{-1}$ so speed $= 5 \text{ ms}^{-1}$	**A1**	Must be positive. If **A0A0**, allow **SCB1** if both are negative
		4	

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Question	Answer	Marks	Guidance
5(b)	$2m\times\left(their\ 3\left[v_P\right]\right)+m\times\left(their\ 5\left[v_Q\right]\right)=2mv+m\times 3.5$	***M1**	Use of conservation of momentum; 4 non- zero terms; using $their \pm 3$ ms^{-1} and $their \pm 5$ ms^{-1}; allow sign errors and m missing ONLY. Do not allow with $v_P=\pm 2$ or with $v_Q=0$. Do not allow made up values for 3 and 5. Allow LHS of our equation to have only one term but only if getting $v_P=0$ in **(a)** from $s_P=s_Q$.
	$v=3.75$	**A1**	Allow $v=-3.75$ from correct work.
	$\left[\text{At } t=\frac{1}{2},\ s_p=\right]\pm\left(2\times\frac{1}{2}-\frac{1}{2}g\left(\frac{1}{2}\right)^2\right)\left[=\mp\frac{1}{4}\right]$ OR $\left[s_p=\right]\pm\left(-3\times\frac{1}{2}+\frac{1}{2}g\left(\frac{1}{2}\right)^2\right)\left[=\mp\frac{1}{4}\right]$ OR $\left[s_p=\right]\pm\left(\frac{(-3)^2-2^2}{2g}\right)\left[=\pm\frac{1}{4}\right]$ OR $\left[\text{At } t=\frac{1}{2},\ s_Q=\right]\pm\frac{1}{2}g\left(\frac{1}{2}\right)^2\left[=\pm\frac{5}{4}\right]$ OR $\left[\text{At } t=\frac{1}{2},\ s_Q=\right]\pm\left(5\times\frac{1}{2}-\frac{1}{2}g\left(\frac{1}{2}\right)^2\right)\left[=\pm\frac{5}{4}\right]$ OR $\left[s_Q=\right]\pm\left(\frac{5^2\left[-0^2\right]}{2g}\right)\left[=\pm\frac{5}{4}\right]$ $\left[\text{so height above ground}=\frac{3}{4}\right]$	***B1**	This may be seen in part **(a)**, but do not award the mark until stated/used in part **(b).**

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Question	Answer	Marks	Guidance
5(b)	$v^2 = (their\ 3.75)^2 + 2\times(\pm g)\times\left(\pm\frac{3}{4}\right)$ OR $0^2 = (their\ 3.75)^2 - 2\times(\pm g)\times s \Rightarrow s = \frac{45}{64}$ AND $v^2 = \left[0^2 + \right] 2\times(\pm g)\times\left[\left(\frac{3}{4}\right) + \frac{45}{64}\right]$	**DM1**	Use of $v^2 = u^2 + 2as$ using their v and $a = \pm g$; $their\ s$ is either $\pm\left[1 + \left(-\frac{1}{4}\right)\right]$ or $\pm\left[2 - \frac{5}{4}\right]$ OE. Dependent on the previous M mark and B mark being awarded.
	$v = 5.39\ \text{ms}^{-1}$	**A1**	Or $\frac{\sqrt{465}}{4}$; AWRT 5.39; 5.390964…
		5	

Question	Answer	Marks	Guidance
6(a)	Attempt to integrate a for $0 \le t \le 1$	**M1**	Increase power by 1 and a change in coefficient in at least one term (which must be the same term); $v = at$ is M0. Expect $(v =) - t^{\frac{3}{2}}\left[+c\right]$.
	$(v =) - \frac{1.5}{1.5}t^{\frac{3}{2}} + 6 = -t^{\frac{3}{2}} + 6$	**A1**	Allow for $-t^{\frac{3}{2}} + c$ and $c = 6$ seen from CWO. Allow unsimplified.
	Velocity at t = 1 is 5 ms^{-1}	**A1**	CWO.
		3	

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Question	Answer	Marks	Guidance
6(b)	Attempt to integrate a for $t>1$ $\left[(v=)\frac{1.5}{3/2}t^{\frac{3}{2}}-\frac{3}{1/2}t^{\frac{1}{2}}[+c]=t^{\frac{3}{2}}-6t^{\frac{1}{2}}[+c]\right]$	***M1**	Increase power by 1 and a change in coefficient in at least one term (which must be the same term); $v=at$ is M0.
	Use $v=their\,5$ when $t=1$ in attempt to find c $[5=1-6+c]$	**DM1**	Must get a numerical expression for c ; if no substitution seen, c must be correct for their expression for v . Their 5 must not be a made up value.
	$(v=)t^{\frac{3}{2}}-6t^{\frac{1}{2}}+10$	**A1**	OE, but must be a complete (possibly unsimplified) expression.
		3	

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Question	Answer	Marks	Guidance
6(c)	For attempt at integration of *their* v for either section	***M1**	Increase power by 1 and a change in coefficient in at least one term (which must be the same term); Their v 's have to come from integration. $s = vt$ is M0. Their v 's have to come from integration.
	$(s_1 =) -\frac{1}{5/2}t^{\frac{5}{2}} + 6t[+c] = -\frac{2}{5}t^{\frac{5}{2}} + 6t[+c]$ $(s_2 =) \frac{1}{5/2}t^{\frac{5}{2}} - \frac{6}{3/2}t^{\frac{3}{2}} + 10t[+c] = \frac{2}{5}t^{\frac{5}{2}} - 4t^{\frac{3}{2}} + 10t[+c]$	**A1**	For either correct. Allow unsimplified.
	For use of limits 0 and 1 for s_1 **and** 1 and 4 for s_2	**DM1**	Using correct limits correctly, in expressions that have come from integration (where all powers must have increased by 1 with a change in coefficient for non-linear terms) of a v that came from integration, and using the limits correctly would lead to 2 positive values when used in their expressions. s_1 and s_2 must have the correct number of non-constant terms and must include a linear term.
	Total distance $= 20\,\text{m}$	**A1**	$s_1 = \left(-\frac{2}{5}\times 1 + 6\times 1\right) - 0\left[= \frac{28}{5} = 5.6\right]$. $s_2 = \left(\frac{2}{5}\times 4^{\frac{5}{2}} - 4\times 4^{\frac{3}{2}} + 10\times 4\right) -$ $\left(\frac{2}{5}\times 1^{\frac{5}{2}} - 4\times 1^{\frac{3}{2}} + 10\times 1\right)\left[= \frac{72}{5} = 14.4\right]$. If either displacement expression has a constant of integration and is given incorrectly, then award **A0** even if 20 m seen. For reference the constant of integration for s_2 is –0.8.

Question	Answer	Marks	Guidance
6(c)	**SC for integration not seen:**		
	$s_1 = \frac{28}{5}$ or $s_2 = \frac{72}{5}$	**B1**	
	Total distance $= 20\,\text{m}$	**B1**	
		4	

Question	Answer	Marks	Guidance
7(a)	$R = 0.2g \times 0.8 [= 1.6]$	**B1**	Allow $\cos 37$ or better for 0.8.
	$F = 1.125R [= 1.8]$	***M1**	Where R is a component of weight. Must have $1.125 \times 0.2g \times 0.8$ or $1.125 \times 0.2g \times 0.6$ or with using $\cos 37$ or $\sin 37$ or better for 0.8 and 0.6 respectively. These 2 marks may be embedded in the N2L equation(s).
	Use of Newton's second law for A or B or system	***M1**	Correct number of terms; allow sign errors; allow sin/cos mix. Dimensionally correct.
	$0.3g - T = 0.3a$ $T + 0.2g \times 0.6 - F = 0.2a$ $0.3g + 0.2g \times 0.6 - F = 0.5a$	**A1**	For any 2 correct equations. Allow $\sin 37$ or better for 0.6. Allow their possibly incorrect F.
	$a = 4.8$ m s^{-2}	**A1**	Must be positive.
	For attempt to solve for T	**DM1**	From equations with the correct number of relevant terms. If a found first then substituting into an equation with the correct number of relevant terms and solving. If resolved equations incorrect and no working seen, then this mark is implied by the correct T value for their equations. Dependent on previous 2 M marks
	$T = 1.56$ N	**A1**	
		7	

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Question	Answer	Marks	Guidance
7(b)	[For B or A] $v^2 = 0^2 + 2\times 4.8\times 0.25$ $\left[\Rightarrow v^2 = 2.4 \text{ or } v = \frac{2\sqrt{15}}{5} = 1.549\ldots\right]$	***M1**	Use of $v^2 = u^2 + 2as$ with $u = 0$ and using $s = 0.25$, $\lvert their\ 4.8\rvert$, $a \neq \pm g$. Must be a complete method to get an expression for v or v^2.
	Attempt at Newton's 2nd Law on A when string becomes slack $\left[0.2g\times 0.6 - 1.125\times 0.2g\times 0.8 = 0.2a\right]$	***M1**	3 terms; allow sign errors; allow sin/cos mix; allow their non-zero F from part **(a)**; Dimensionally correct; must be using 0.2 for the mass. Allow $\theta = 37$ or better. For reference $a = -3$ (or -2.99 if using $\theta = 36.9$).
	$0^2 = 2.4 + 2\times(-3)\times s \left[\Rightarrow s = 0.4\right]$	**DM1**	Using constant acceleration formula(e) using a negative acceleration to get an expression in s only. Dependent on previous 2 M marks.
	Total distance = 0.25 + 0.4 = 0.65 m	**A1**	AWRT 0.650. Allow 0.651 from use of $\theta = 36.9$.
	ALTERNATIVE for 7(b) using energy:		
	[For B or A] $v^2 = 0^2 + 2\times 4.8\times 0.25$ $\left[\Rightarrow v^2 = 2.4 \text{ or } v = \frac{2\sqrt{15}}{5} = 1.549\ldots\right]$	***M1**	Use of $v^2 = u^2 + 2as$ with $u = 0$. Using $s = 0.25$, $\lvert their\ 4.8\rvert$, $a \neq \pm g$. Must be a complete method to get an expression for v or v^2.
	For attempt at work energy equation	**DM1**	3 terms; dimensionally correct; allow sin/cos mix in PE term and work done against Friction term; allow sign errors; allow their non-zero F from part **(a)**.

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Question	Answer	Marks	Guidance
7(b)	$\frac{1}{2}\times 0.2\times 2.4+0.2g\times 0.6\times d-1.125\times 0.2g\times 0.8\times d=0$ $\left[\Rightarrow d=0.4\text{m}\right]$	**A1**	For correct equation in d only; must be using 0.2 for the mass. Allow $\theta=37$ or better.
	Total distance = 0.25 + 0.4 = 0.65 m	**A1**	AWRT 0.650. Allow 0.651 from use of $\theta=36.9$.
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