CAMBRIDGE
International Education

Cambridge International AS & A Level

MATHEMATICS **9709/45**

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)	$\frac{1}{2}(2+6)\times 20+(30-20)\times 6+\frac{1}{2}(6+0)\times(50-30)-\frac{1}{2}\times(90-50)\times 3$ $\frac{1}{2}(2+6)\times 20+10\times 6+\frac{1}{2}(6+0)\times 20-\frac{1}{2}\times 40\times 3$ $[=80+60+60-60]$	**M1**	OE. For attempt to find distance or area under the graph. Allow term(s) for area under axis to be added rather than subtracted from the other terms and one other error but all areas accounted for. Must use initial velocity of 2, not 0 so 0 scores **M0**. Note: 260 usually scores **M1A0.**
	140 m	**A1**	
		2	
1(b)	$\left[\frac{1}{2}(2+6)\times 20+10\times 6+\frac{1}{2}(6+0)\times 20+\frac{1}{2}\times 40\times 3=\right]260$ m	**B1**	
		1	

Question	Answer	Marks	Guidance
2(a)	**EITHER:** Attempt at Newton's second law for at least one case	**(*M1**	Correct number of terms, dimensionally consistent, allow sign errors.
	$0.4g - T = 0.4a$ $T = 0.6a$ $0.4g = (0.4 + 0.6)a$	**A1**	For any two correct. Must be the same T and the same a to score **A1**. Can score **M1A1** with consistent 'wrong' direction of a.
	Attempt to solve for tension or acceleration	**DM1**	From equations with the correct number of relevant terms to get '$a =$' or '$T =$'. Correct answers without working score full marks provided correct equations seen. If no working shown both T and a must be correct for their equations to score **M1.**
	Tension = 2.4 N or $\frac{12}{5}$ N Acceleration = 4 m s^{-2}	**A1)**	May find $a = -4$ and state magnitude = 4.
	OR: **Alternative using energy to find acceleration**		
	Attempt at energy equation for system or for A or B	**(M1**	Must have correct number of terms. Allow sign errors.
	For system: $\frac{1}{2}(0.6 + 0.4)v^2 = 0.4g \times 0.5$ For A: $T \times 0.5 = \frac{1}{2} \times 0.6v^2$ and for B: $0.4g \times 0.5 - T \times 0.5 = \frac{1}{2} \times 0.4v^2$ $\left[\Rightarrow v^2 = 4 \Rightarrow 4 = 0 + 2a \times 0.5\right]$	**A1**	For two equations. May have a combination of this method and that in the main scheme.
	Attempt to solve for tension or acceleration	**DM1**	From equations with the correct number of relevant terms, to get '$a =$' or '$T =$'. If no working shown both T and a must be correct for their equations to score **M1.**

Question	Answer	Marks	Guidance
2(a)	Tension = 2.4 N or $\frac{12}{5}$ N Acceleration = 4 m s^{-2}	**A1)**	
	Available marks	**4**	
2(b)	$0.5 = 0 + \frac{1}{2} \times 4 \times t^2$ using *their a* Or $v^2 = 0^2 + 2 \times 4 \times 0.5 \Rightarrow v = 2$ and $2 = 0 + 4t$	**M1**	For use of correct constant acceleration formula to get an equation in t only using ± 0.5 and $\pm$*their a*.
	Time = 0.5 s ONLY 2	**A1**	Can also score **A1** if $a = -4$ in **2(a)** but use $a = 4$. If using $s = 0.5$ and $a = -4$ then **A0**.
		2	

Question	Answer	Marks	Guidance
3	For resolving in any direction to form an equation	*M1	Correct number of relevant terms with all forces resolved (or not) as appropriate; allow sign errors; allow consistent sin/cos mix.
	$15+25\cos 30=20\cos 70+F\cos\theta$ $[F\cos\theta=29.8102\ldots]$	A1	
	$20\sin 70=25\sin 30+F\sin\theta$ $[F\sin\theta=6.29385\ldots]$	A1	
	For reasonable attempt to find θ $\theta=\tan^{-1}\left(\frac{6.29385\ldots}{29.8102\ldots}\right)$ or, $\theta=\sin^{-1}\left(\frac{6.29385\ldots}{their\ F}\right)$ or, $\theta=\cos^{-1}\left(\frac{29.8102\ldots}{their\ F}\right)$	DM1	From equations with correct number of relevant terms. Must get to '$\theta=$'. Allow use of their F provided correctly derived from equations with the correct number of relevant terms.
	For reasonable attempt to find F $F=\sqrt{(6.29385\ldots)^2+(29.8102\ldots)^2}$ or, $F=\frac{29.8102\ldots}{\cos(their\ \theta)}$ or, $F=\frac{6.29385\ldots}{\sin(their\ \theta)}$	DM1	From equations with correct number of relevant terms. Must get to '$F=$'. Allow use of their θ provided correctly derived from equations with the correct number of relevant terms.
	$F=30.5$ $\theta=11.9$	A1	AWRT 30.5 $(30.4674\ldots)$, AWRT 11.9 $(11.9218\ldots)$.
		6	

Question	Answer	Marks	Guidance
4(a)	**EITHER:** Speed = $\frac{1400}{70}[=20]$	**(*B1**	
	Force supplied by engine = $\frac{15000}{20}[=750]$ or $20F=15000$ may see N2L: $\frac{15000}{20}-F=1200\times 0$	**DM1**	For use of power = Fv with *their* speed. May use R rather than F.
	$R=750$	**A1)**	Do not allow 'Driving force = 750 N' or '$F=750$ N' without mention of R but allow an answer of 750 N if neither driving force nor R mentioned.
	OR: **Alternative method using energy**		
	Work done by the driving force $=15000\times 70[=1050000]$	**(*B1**	OE.
	$15000\times 70-F\times 1400=0$	**DM1**	For work energy equation with 2 relevant dimensionally correct terms. May use R rather than F
	$R=750$	**A1)**	Do not allow 'Driving force = 750 N' without mention of R but allow an answer of 750 N if neither driving force nor R mentioned.
	Available marks	**3**	

Question	Answer	Marks	Guidance
4(b)	Work done by $R = \pm 750 \times 460$ [$= \pm 345000$]	**B1**	
	Change in KE $= \pm(\frac{1}{2} \times 1200 \times 32^2 - \frac{1}{2} \times 1200 \times (their\ 20)^2)$ [$= 374400$]	**B1**	For change in KE, using their 20.
	$42000t = \frac{1}{2} \times 1200 \times 32^2 - \frac{1}{2} \times 1200 \times 20^2 + 750 \times 460$	**M1**	Attempt at work energy equation with 4 relevant terms; dimensionally correct. Allow sign errors, but must be a change in KE, using their 20.
	Time = 17.1 s	**A1**	
		4	

Question	Answer	Marks	Guidance
5(a)	Attempt to integrate	*M1	The power of t must increase by 1 with a change of coefficient in the same term. Allow un-simplified. Use of $s = vt$ scores **M0**.
	$s = 3t^2 - \frac{2}{5}t^{\frac{5}{2}}[+c]$	A1	Allow un-simplified $s = \frac{6}{2}t^{1+1} - \frac{1}{\frac{3}{2}+1}t^{\frac{3}{2}+1}[+c]$.
	$700 = 3\times 25^2 - \frac{2}{5}\times 25^{\frac{5}{2}} + c$ or $700 = 625 + c$ Or $\left[700 - \left[3t^2 - \frac{2}{5}t^{\frac{5}{2}}\right]_0^{25} = \right] 700 - \left(3\times 25^2 - \frac{2}{5}\times 25^{\frac{5}{2}}\right)$ or $700 - 625$	DM1	Sub $t = 25, s = 700$ into their integrated expression which has a constant of integration. Allow use of $c = 0$ (provided that c is mentioned) as this is simply taking the starting point as A, but must also use 700. If using the second method, they must have $700 - \textit{their}\,625$, not $700 + \textit{their}\,625$. For both methods, if their expression for s is wrong then substitution of 25 has to be shown to score **M1**.
	$OA = 75$ m	A1	Do not allow '$c = 75$' without mention of OA or s, but allow an answer of 75 without specifying what it is. **SCB1** for correct answer with no integration seen and no incorrect working.
		4	

Question	Answer	Marks	Guidance
5(b)	$a = 6 - \frac{3}{2}t^{\frac{1}{2}}$	*M1	Attempt to differentiate to get $a = 6 - kt^{\frac{1}{2}}$, where $k \neq 1, k \neq 0$. Use of $a = \frac{v}{t}$ scores **M0**.
	$\left[a = 0 \text{ when } 6 - \frac{3}{2}t^{\frac{1}{2}} = 0 \Rightarrow\right] t = 16$	A1	
	$v = 6t - t^{\frac{3}{2}} = 0$ when $t\left(6 - t^{\frac{1}{2}}\right) = 0$	*M1	For attempt to solve. Must get to '$t =$' where $t \neq 0$. May also have $t = 0$.
	$t = 36$	A1	
	$\left(3 \times 36^2 - \frac{2}{5} \times 36^{\frac{5}{2}}[+ \textit{their } 75]\right) - \left(3 \times 16^2 - \frac{2}{5} \times 16^{\frac{5}{2}}[+\textit{their } 75]\right)$ $\left[= 777.6[+\textit{their } 75] - 358.4[+\textit{their } 75] = \frac{3888}{5} - \frac{1792}{5}\right]$	DM1	Dep on both previous **M1** marks. For correct use of their limits (found from v and a). Must be using s from integration in **Q5(a)** (or from a new start here) with usual rules. **M0** if other distance(s) also included. If limits wrong or their expression for s wrong then substitution has to be shown to score **M1**.
	$= \frac{2096}{5} = 419.2$ m	A1	Allow 419. **SCB1** for correct answer with no integration seen and no incorrect working. Max 5 marks out of 6. Allow even if c is wrong.
		6	

Question	Answer	Marks	Guidance
6(a)	**EITHER:** $R_P = 0.3g \times 0.96 \quad [= 2.88]$ or $R_Q = 0.6g \times 0.96 \; [= 5.76]$ or $R_m = mg \times 0.96 \; [= 9.6m]$	**(*B1**	Check diagram if no correct working seen. May be embedded in friction term. Can use $\sin 16$ and $\cos 16$ in place of 0.28 and 0.96 respectively throughout the question.
	If do not move then For P: $0.5 \times 0.3g \times 0.96 > 0.3g \times 0.28$ or $[1.44 > 0.84]$ or ± 0.6 **AND** For Q $0.5 \times 0.6g \times 0.96 > 0.6g \times 0.28$ or $[2.88 > 1.68]$ or ± 1.2 OR For m: $0.5 \times mg \times 0.96 > mg \times 0.28$ or $[4.8[m] > 2.8[m]]$ or $\pm 2[m]$	**DB1**	For correct comparison of correct weight component and correct maximum friction force for both particles or for particle of mass m or difference between them. OE e.g. $0.5 \times 0.3g\cos 16 > 0.3g \sin 16$. Ok to compare expressions once values seen e.g. Max friction > weight component.
	For P: $1.44 > 0.84$ or $\frac{36}{25} > \frac{21}{25}$ or $0.6 > 0$ or $-0.6 < 0$ so do not move For Q: $2.88 > 1.68$ or $\frac{72}{25} > \frac{42}{25}$ or $1.2 > 0$ or $-1.2 < 0$ so do not move For m: $4.8[m] > 2.8[m]$ or $\frac{24}{5}[m] > \frac{14}{5}[m]$ or $2[m] > 0$ or $-2[m] < 0$ so do not move	**B1)**	Fully correct justification for both particles or for particle of mass m and statement that neither particle moves. Condone use of 16° rather than 16.3°
	OR: **Alternative method considering acceleration for last two marks**		
	For P: $0.3g \times 0.28 - 0.5 \times 0.3g \times 0.96 = 0.3a$ or $0.84 - 1.44 = 0.3a$ **AND** For Q $0.6g \times 0.28 - 0.5 \times 0.6g \times 0.96 = 0.6a$ or $1.68 - 2.88 = 0.6a$ OR For m: $mg \times 0.28 - 0.5 \times mg \times 0.96 = ma$ or $0.28mg - 0.48mg = ma$	**(DB1**	OE. For correct Newton's second law for both particles or for the particle of mass m.
	$a = -2$ so neither particle moves	**B1)**	

Question	Answer	Marks	Guidance
6(a)	**OR:** **Alternative method considering angle of friction**		
	$\tan\alpha = \frac{7}{24}$	**(*B1**	OE.
	$\frac{7}{24} = 0.2916\ldots < 0.5$	**DB1**	
	So neither particle moves.	**B1)**	
	Available marks	**3**	

Question	Answer	Marks	Guidance
6(b)	**EITHER:** $0.3g \times 0.28 - 0.5 \times 0.3g \times 0.96 = 0.3a$ Or $0.84 - 1.44 = 0.3a$ Or $\frac{21}{25} - \frac{36}{25} = 0.3a$ Or e.g. $0.5 \times 0.3g \times 0.96 - 0.3g \times 0.28 = 0.3a$	**(*M1**	Use of N2L; correct number of relevant terms, allow sign errors and sin/cos mix, dimensionally consistent. Do not allow g missing.
		A1	For correct equation in a. For reference $a = -2$ Note that candidates may find a in **6(a)** and use it in **6(b)**. In this case link the two parts. OE from taking up as positive.
	Eg $v^2 = 6^2 - 2 \times 2 \times 2.75$ with $\pm$ *their a* Eg $2.75 = 6t + \frac{1}{2}(-2)t^2 \Rightarrow t = 0.5$ (and 5.5) $\Rightarrow v = 6 - 2(0.5)[= 5]$	**DM1**	Use of suvat to get an equation in v or v^2 using $u = \pm 6$ and $s = \pm 2.75$.
	[Speed =] 5 ms^{-1} Do not allow ± 5	**A1)**	Condone use of $a = -2$ when they get $a = 2$ from their working. Using angle 16.3 leads to $a = -1.992\ldots$ and speed = 5.00420… and gets full marks. Using angle 16 leads to $a = -2.049\ldots$ and speed = 4.9724… and gets 3 out of 4.
	OR: **Alternative method using energy (no need to find *a* using this method)**		
	Change in KE $= \pm\left(\frac{1}{2} \times 0.3 \times 6^2 - \frac{1}{2} \times 0.3 \times v^2\right)$ $\left[= \pm\left(5.4 - \frac{1}{2} \times 0.3v^2\right)\right]$ Or Change in PE $= \pm 0.3g \times 2.75 \times 0.28$ $[= \pm 0.3g \times 0.77 = \pm 2.31]$	**(B1**	For either change in KE or in PE.
	Work done by friction = $0.5 \times 0.3g \times 0.96 \times 2.75$	**B1**	

Question	Answer	Marks	Guidance
6(b)	$\frac{1}{2}\times 0.3\times 6^2-\frac{1}{2}\times 0.3\times v^2+0.3g\times 2.75\times 0.28$ $-0.5\times 0.3g\times 0.96\times 2.75=0$ Or $5.4-\frac{1}{2}\times 0.3v^2+2.31-3.96=0$	**M1**	Energy equation. Dimensionally correct with correct number of relevant terms. Allow sign errors and sin/cos mix but KE change must be a difference, not a sum.
	Speed = 5 m s^{-1} Do not allow ± 5	**A1)**	
	Available marks	**4**	

Question	Answer	Marks	Guidance
6(c)	**EITHER:** $0.3\times \textit{their}\, 5 = 0.3\times(-1)+0.6\times w$	**(*M1**	Use of conservation of momentum. Correct number of relevant non-zero terms, allow sign errors. Must use *their* $5\neq 6$. unless get answer of 6 in **6(b).**
	Speed of $Q = 3$	**A1**	Condone 2.99 from use of $\alpha = 16$.
	For Q $a=-2$ so $0=3^2-2\times 2s$ $\left[s=2.25=\frac{9}{4}\right]$ Or $0=3-2t \Rightarrow t=\frac{3}{2}$ $\Rightarrow s=3\times\frac{3}{2}+\frac{1}{2}\times(-2)\left(\frac{3}{2}\right)^2$ $\left[s=2.25=\frac{9}{4}\right]$	**DM1**	Using *their* speed of Q and *their* a found in **Q6(a)** or **Q6(b)** or found again here in **Q6(c)** to form an equation in s. Allow sign errors. Note that in whichever part the acceleration a is found; there must be the correct number of relevant terms, allow sign errors and sin/cos mix, dimensionally consistent. Do not allow g missing.
	For P $-0.3g\times 0.28-0.5\times 0.3g\times 0.96=0.3a\left[a=-7.6\right]$ Or $-0.84-1.44=0.3a$ or $-2.28=0.3a$ Or $0.3g\times 0.28+0.5\times 0.3g\times 0.96=0.3a\left[a=7.6\right]$ Or $0.84+1.44=0.3a$ or $2.28=0.3a$	**M1**	Use of N2L up the plane; correct number of relevant terms, and sin/cos mix, dimensionally consistent. Do not allow g missing. Do NOT allow sign errors.
	$\left[0=1^2-2\times 7.6s\Rightarrow s=0.06578\ldots=\frac{5}{76}\right]$ so total distance = 2.32 m or $\frac{44}{19}$ m	**A1)**	Awrt 2.32 (2.3157…) Using angle 16.3 leads to speed of $Q = 3.0021\ldots$, dist $Q = 2.26179\ldots$, dist $P = 0.06574\ldots$ Total = 2.32753… and gets 4 marks out of 5. Using angle 16 leads to speed of $Q = 2.98623\ldots$, dist $Q = 2.17509\ldots$, dist $P = 0.06611\ldots$ Total = 2.2412… and gets 4 marks out of 5.
	OR: **Alternative method using energy**		
	$0.3\times \textit{their}\, 5 = 0.3\times(-1)+0.6\times w$	**(*M1**	Use of conservation of momentum. Correct number of non-zero terms, allow sign errors. Must use *their* $5\neq 6$ . . unless get answer of 6 in **6(b)**.

Question	Answer	Marks	Guidance
6(c)	Speed of $Q = 3$	**A1**	Condone 2.99 from use of $\alpha = 16$.
	For Q $\frac{1}{2}\times 0.6\times 3^2 - \frac{1}{2}\times 0.6\times 0^2 + 0.6g\times s\times 0.28 - 0.5\times 0.6g\times 0.96s = 0$ $[2.7 + 1.68s - 2.88s = 0]$ $\left[s = 2.25 = \frac{9}{4}\right]$	**DM1**	Energy equation for Q using *their* speed of Q. Dimensionally correct with correct number of relevant terms. Allow sign errors and sin/cos mix.
	For P $\frac{1}{2}\times 0.3\times 1^2 - \frac{1}{2}\times 0.3\times 0^2 - 0.3g\times s\times 0.28 - 0.5\times 0.3g\times 0.96s = 0$ $[0.15 - 0.84s - 1.44s = 0]\left[s = 0.06578\ldots = \frac{5}{76}\right]$	**M1**	Energy equation for P. Dimensionally correct with correct number of relevant terms. Do NOT allow sign errors in the two terms involving s *but* allow sin/cos mix.
	so total distance = 2.32 m or $\frac{44}{19}$ m	**A1)**	Awrt 2.32 (2.3157…).
	Available marks	**5**	

Question	Answer	Marks	Guidance
7	**EITHER:** For any one correct equation involving a and u (the velocity at A which may be labelled v_A)	**(*B1**	
	$[s_{AB} =]50 = u\times10 + \frac{1}{2}a\times10^2$ or $50 = 10u + 50a$ or $u + 5a = 5$ oe $[s_{CD} =]100 = (u + 20a)\times10 + \frac{1}{2}a\times10^2$ or $100 = 10u + 250a$ or $u + 25a = 10$ oe $[s_{CD} =]100 = \frac{(u + 10\times2a + u + 10\times3a)}{2}\times10$ or $100 = \frac{10(2u + 50a)}{2}$ oe $[v_B^2 =](u + 10a)^2 = u^2 + 2a\times50$ $[v_D^2 =](u + 30a)^2 = (u + 20a)^2 + 2a\times100$ For reference: $v_A = u$ $u = 5 - 5a$ $v_A = 5 - 5a$ $v_B = u + 10a$ $v_B = 5 + 5a$ $v_B = 10 - u$ $v_C = u + 20a$ $v_C = 5 + 15a$ $v_C = 20 - 3u$ $v_D = u + 30a$ $v_D = 5 + 25a$ $v_D = 3u$	***B1**	For a second different correct equation involving a and the velocity at A. Note: Equations 1 and 4 are equivalent. Equations 2, 3 and 5 are equivalent. Eg may use $50 = v_B\times10 - \frac{1}{2}a\times10^2$, where $v_B = u + 10a$. Note: Equation 2 could come from: $100 = v_C\times10 + \frac{1}{2}a\times10^2$ and $v_C = u + 20a$ Or $100 = v_D\times10 - \frac{1}{2}a\times10^2$ and $v_D = u + 30a$. For reference: Equations 1 and 2 combined can lead to e.g. $100 = 50 + 150a + 50a$.
	For attempt to solve for a to get to '$a =$'	**DM1**	If no working, then must get $a = 0.25$. Dep on both **B1** marks.
	$a = 0.25$	**A1**	
	Increase in speed $= 0.25\times30$ or $v_D - u = 11.25 - 3.75$	**DM1**	Must be using the correct phases (final – initial). Dep on all previous **M** and **B** marks.
	7.5 ms^{-1}	**A1)**	

Question	Answer	Marks	Guidance
7	**OR:** **Alternative scheme for second B1 using velocities at *A* and *C***		
	$[s_{CD} =]100 = v_C \times 10 + \frac{1}{2}a \times 10^2$ or $100 = 10v_C + 50a$ $\Rightarrow 10v_C - 10u = 50$ $[v_C - u = 5]$ **AND** $v_C - u = 20a$ $[20a = 5]$	**(*B1)**	Note: $10v_C - 10u = 50$ comes from solving the two equations $50 = 10u + 50a$ and $100 = 10v_C + 50a$.
	All other marks as in main scheme		
	OR: **Alternative scheme using velocities after 5s and 25s** [from average velocity in 1st and 3rd phases, which occurs at phase midpoint]		
	$[\text{Speed at } 5s] = \frac{50}{10}[=5]$	**(*B1**	
	$[\text{Speed at } 25s] = \frac{100}{10}[=10]$	***B1**	
	For use of constant acceleration formula for 20 s interval Eg $10 = 5 + a \times 20$.	**DM1**	Must use a time of 20 s unless the velocity at the midpoint of *BC* is found, in which case can use a time of 10 s. It is unlikely that candidates will state that this is the velocity at the midpoint of *BC*. Dep on both **B1** marks.
	$a = 0.25$	**A1**	
	Increase in speed $= 0.25 \times 30$ or $v_D - v_A = 11.25 - 3.75$	**DM1**	Dep on all previous **M** and **B** marks.
	7.5 m s^{-1}	**A1)**	
	Available marks	**6**	