Cambridge Assessment International Education

Cambridge International AS & A Level

MATHEMATICS **9709/42**

Paper 4 Mechanics **May/June 2023**

MARK SCHEME

Maximum Mark: 50

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2023 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

[Turn over

PUBLISHED

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:
Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:
Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:
Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:
Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:
Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:
Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Mathematics Specific Marking Principles	
1	Unless a particular method has been specified in the question, full marks may be awarded for any correct method. However, if a calculation is required then no marks will be awarded for a scale drawing.
2	Unless specified in the question, 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 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 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.

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	$12^2 = 2\times 9\times a$. **OR** $a = 8$.	**M1**	Use of suvat to get an equation in a.
	$1.6g - R = 1.6a$. [may see $R = 3.2$]	**M1**	Use Newton's second law with 3 terms, allow sign errors. Allow *their* $a \neq g$. Allow a if it isn't subsequently replaced with g.
	WD $\left[= 3.2\times 9\right] = 28.8$ J	**A1**	
	Alternative method for Question 1		
	(KE =) $\frac{1}{2}\times 1.6\times 12^2$ **OR** 115.2	**B1**	Allow for the expression for KE.
	(Loss of PE =) $\pm 1.6g\times 9$ **OR** ± 144	**B1**	Allow for the expression for PE.
	WD $= 28.8$ J	**B1**	Allow if get –28.8 and then say 28.8 without explanation. Do not allow –28.8 as final answer to working, so if get 28.8 and state –28.8 then ISW.
		3	

Question	Answer	Marks	Guidance
2(a)	$\pm\left[3.2v + 2.4\times(-6)\right] = 0$	**M1**	Attempt at conservation of momentum; 2 non-zero terms; allow sign errors.
	$v = 4.5$	**A1**	M1A0 for use of mgv. $v = -4.5$ is A0.
		2	

Question	Answer	Marks	Guidance
2(b)	$\text{KE} = \pm\frac{1}{2}\times 3.2\times(\textit{their}\ 4.5)^2$ OR $\pm\frac{1}{2}\times 2.4\times 6^2$	**M1**	Attempt at either KE term, using *their v*. Do not allow $\frac{1}{2}\times 3.2\times(\textit{their}\ 4.5\pm 6)^2$, or $\frac{1}{2}\times 2.4\times(\textit{their}\ 4.5\pm 6)^2$, or $\frac{1}{2}\times(3.2+2.4)\times(\textit{their}\ 4.5\pm 6)^2$, or $\frac{1}{2}\times 3.2\times(\textit{their}\ 4.5-0)^2$, or $\frac{1}{2}\times 2.4\times(6-0)^2$.
	$\text{KE}_{\text{loss}} = 75.6\,\text{J}$	**A1**	Allow –75.6. Note $\frac{1}{2}\times(3.2+2.4)\times 6^2$ or $\frac{1}{2}\times(3.2+2.4)\times(\textit{their}\ 4.5)^2$ is M1A0.
		2	

Question	Answer	Marks	Guidance
3(a)	Resolving either direction.	**M1**	Correct number of terms, allow sign errors, allow sin/cos mix. Do not allow with just $\sin\alpha$ and $\cos\alpha$.
	$(33+15)\times\frac{3}{5}=P\cos\theta+30\cos\theta$ OR $(33+15)\cos\left(\tan^{-1}\frac{4}{3}\right)=P\cos\theta+30\cos\theta$ OR $19.8+9=P\cos\theta+30\cos\theta$	**A1**	OE, but see note for final A1. Allow: $28.8=(P+30)\cos\theta$ $(33+15)\cos 53(.1)=P\cos\theta+30\cos\theta$ $19.81+9.01=P\cos\theta+30\cos\theta$ $19.86+9.03=P\cos\theta+30\cos\theta$.
	$15\times\frac{4}{5}+30\sin\theta=33\times\frac{4}{5}+P\sin\theta$ OR $15\sin\left(\tan^{-1}\frac{4}{3}\right)+30\sin\theta=33\sin\left(\tan^{-1}\frac{4}{3}\right)+P\sin\theta$ OR $12+30\sin\theta=26.4+P\sin\theta$	**A1**	OE, but see note for final A1. Allow: $14.4=(30-P)\sin\theta$ $15\sin 53(.1)+30\sin\theta=33\sin 53(.1)+P\sin\theta$ $12.00+30\sin\theta=26.39+P\sin\theta$ $11.98+30\sin\theta=26.35+P\sin\theta$.
	[Use $\cos^2\theta+\sin^2\theta=1$ with] $\cos\theta=\frac{28.8}{P+30}$ and $\sin\theta=\frac{14.4}{30-P}$ to get $\left(\frac{14.4}{30-P}\right)^2+\left(\frac{28.8}{P+30}\right)^2=1$	**A1**	AG**.** Must have evidence of where 28.8 and 14.4 come from. A0 for any error seen. A0 if use of inexact angles seen. Any inexact decimals seen for force components, i.e. if 14.4 and/or 28.8 have come from rounding to 3sf, scores M1A1A1A0 max 3/4. If exact values of $\sin\alpha$ and $\cos\alpha$ not shown (e.g. $28.8=(P+30)\cos\theta$ or $14.4=(30-P)\sin\theta$ from no working), this scores M1A1A1A0 max 3/4 marks.
		4	

Question	Answer	Marks	Guidance
3(b)	Sub $P = 6$ into $\left(\frac{14.4}{30-P}\right)^2 + \left(\frac{28.8}{P+30}\right)^2$ to get $\left[\left(\frac{14.4}{24}\right)^2 + \left(\frac{28.8}{36}\right)^2\right] = \left(\frac{3}{5}\right)^2 + \left(\frac{4}{5}\right)^2 = 0.36 + 0.64 = 1$	**B1**	Must see either $\left(\frac{3}{5}\right)^2 + \left(\frac{4}{5}\right)^2 = 1$ or $0.36 + 0.64 = 1$ as minimum working.
	$\theta = 36.9$	**B1**	AWRT 36.9 .
		2	

Question	Answer	Marks	Guidance
4(a)	$\left(\text{Resistive force} = DF = \frac{60}{3} = \right) 20\,\text{N}$	**B1**	
		1	

Question	Answer	Marks	Guidance
4(b)	PE $= \pm 84g \times 150 \sin 0.8$	**B1**	$\pm 1759.23\ldots$
	KE change $= \pm\left(\frac{1}{2} \times 84v^2 - \frac{1}{2} \times 84 \times 3^2\right)$	**B1**	$\pm\left(\frac{1}{2} \times 84v^2 - 378\right)$
	Work Done $= \pm(24 \times 150 - 13 \times 150)$	**B1**	$\pm(3600 - 1950) = \pm 1650$
	Attempt at work-energy equation.	**M1**	5 terms, dimensionally correct, allow sign errors, sin/cos mix on PE term, PE must include $\sin 0.8$ or $\cos 0.8$.
	$84g \times 150 \sin 0.8 + \frac{1}{2} \times 84v^2 - \frac{1}{2} \times 84 \times 3^2 = 24 \times 150 - 13 \times 150$ $\left[1759.23\ldots + 42v^2 - 378 = 3600 - 1950 \rightarrow 42v^2 = 268.765\ldots\right]$	**A1**	
	$[v =]$ 2.53 m s^{-1}	**A1**	AWRT 2.53; 2.5296…
		6	
	Special case for use of constant acceleration: Maximum 4 marks		
	Resolve parallel to slope and use Newton's second law	***M1**	Four terms, allow sign errors, allow sin/cos mix.
	$24 - 13 - 84g \sin 0.8 = \pm 84a$	**A1**	For reference $a = \pm 0.008669\ldots$
	Use constant acceleration formula to get an equation in v or v^2	**DM1**	E.g. $v^2 = 3^2 + 2 \times (their\ a) \times 150$.
	$[v =]$ 2.53 m s^{-1}	**A1**	AWRT 2.53; 2.5296…
		4	

Question	Answer	Marks	Guidance
5	Attempt at resolving parallel or perpendicular to the plane.	***M1**	3 terms, allow sign errors, allow sin/cos mix, allow g missing. Forces that need resolving should be resolved, forces that do not need resolving should not be resolved.
	$R = P\sin 35 + 0.6g\cos 35$ $\left[R = (0.573\ldots)P + 4.914\ldots\right]$	**A1**	
	$F + P\cos 35 = 0.6g\sin 35$ $\left[F + (0.819\ldots)P = 3.441\ldots\right]$	**A1**	Their F.
	Use of $F = 0.4R$	***M1**	Where R is initially a linear combination of a P component and a weight component (or a mass component).
	Solve for P.	**DM1**	From equations with the correct number of relevant resolved terms. $R = \dfrac{0.6g}{\cos 35 + 0.4\sin 35} = 5.7222$. Must get to $P =$ …, e.g. $P = \dfrac{0.6g\sin 35 - 0.4\times 0.6g\cos 35}{\cos 35 + 0.4\sin 35}$ If no working seen, allow this mark if correct solution for their equations. If $F \leqslant 0.4R$ used, it should be used correctly. e.g. $0.6g\sin 35 - P\cos 35 \leqslant 0.4(P\sin 35 + 0.6g\cos 35)$.
	$P = 1.41$	**A1**	AWRT 1.41 . If $P \geqslant 1.41$ seen, must then state the least value explicitly for A1.

Question	Answer	Marks	Guidance
5	**Alternative for Question 5: Resolving vertically and horizontally**		
	Attempt at resolving vertically or horizontally.	***M1**	3 terms, allow sign errors, allow sin/cos mix, allow g missing. Forces that need resolving should be resolved, forces that do not need resolving should not be resolved.
	$R\cos 35 + F\sin 35 = 0.6g$	**A1**	*Their F* or *R*.
	$P + F\cos 35 = R\sin 35$	**A1**	*Their F* or *R*.
	Use of $F = 0.4R$	***M1**	To get 2 equations, one in R (or F) and the other in P and R (or P and F) from resolved equations with correct number of relevant terms. Allow g missing.
	Solve for P	**DM1**	From equations with the correct number of relevant resolved terms. May see $R = \dfrac{0.6g}{\cos 35 + 0.4\sin 35} = 5.7222$; Must get to $P = \ldots$, e.g. $P = \dfrac{0.6g\sin 35 - 0.4\times 0.6g\cos 35}{\cos 35 + 0.4\sin 35}$. If no working seen, allow this mark if correct solution for *their* equations.
	$P = 1.41$	**A1**	AWRT 1.41 .
		6	

Question	Answer	Marks	Guidance
6(a)	$4b+4^{\frac{3}{2}}c=8\left[\rightarrow 4b+8c=8\right]$ and $9b+9^{\frac{3}{2}}c=13.5\left[\rightarrow 9b+27c=13.5\right]$ State $b=3$ and $c=-0.5$ OR $3\times 4+(-0.5)\times 4^{\frac{3}{2}}=8$ AND $3\times 9+(-0.5)\times 9^{\frac{3}{2}}=13.5$	**B1**	Must have 2 correct equations, which do not have to be simplified. Allow to just state the values of b and c. Allow substitution of $b=3$ and $c=-0.5$ in both equations to verify. No further calculation required. B0 if any incorrect work seen.
		1	
6(b)	$\left(a=\frac{\mathrm{d}v}{\mathrm{d}t}=\right)3-0.5\times\frac{3}{2}\times t^{\frac{1}{2}}$ OR $b+c\times\frac{3}{2}\times t^{\frac{1}{2}}$	**M1**	Attempt to differentiate, decrease power by 1 and a change in coefficient in at least one term (which must be the same term); allow unsimplified; $a=\frac{v}{t}$ is M0.
	acceleration = 2.25 $\mathrm{m\,s^{-2}}$	**A1**	OE, e.g. $\frac{9}{4}$ or $2\frac{1}{4}$. **SC B1** for 2.25 if no differentiation seen.
		2	

Question	Answer	Marks	Guidance
6(c)	Equate v to 0 and attempt to solve for t	**M1**	Must get to $t = \ldots$ and must be positive.
	$t = 36$ ONLY	**A1**	WWW. Allow if $t = 0$ seen and not rejected.
	Attempt to integrate	**M1**	Increase power by 1 and a change in coefficient in at least one term (which must be the same term). $s = vt$ is M0.
	$s = \frac{3}{2}t^2 - 0.5 \times \frac{2}{5} \times t^{\frac{5}{2}}(+D) = \frac{3}{2}t^2 - \frac{1}{5}t^{\frac{5}{2}}(+D)$ OR $s = \frac{b}{2}t^2 + c \times \frac{2}{5} \times t^{\frac{5}{2}}(+D)$	**A1**	Allow unsimplified (including indices).
	Sub $t = 36$ (or use limits 36 and 0) to get distance = 388.8 m ONLY	**A1**	Allow 389 m. If no integration seen for the last 3 marks, allow **SC B1** for 388.8 m. Max M1A1B1 for 3/5 marks.
		5	
6(d)	$\frac{3}{2}t^2 - 0.5 \times \frac{2}{5} \times t^{\frac{5}{2}} = 0$	**M1**	Equate *their s* (that has come from an integration attempt) to 0 and attempt to solve for *t*. Must get to $t = \ldots$
	$t = 56.25$	**A1**	WWW. OE, e.g. $\frac{225}{4}$. Allow 2sf or better. Allow any correct unsimplified expression equivalent to 56.25 e.g. $\frac{15^2}{2^2}$ or 7.5^2.
	Speed = 42.2 m s^{-1} ONLY	**A1**	AWRT 42.2 . Speed = –42.2 is A0. Allow A1 if negative sign dropped without justification.
		3	

Question	Answer	Marks	Guidance
7(a)(i)	Particle P: $2g\sin 30 - F - T = 2a$ $\left[10 - F - T = 2a\right]$ Particle Q: $T - 0.25g = 0.25a$ System: $2g\sin 30 - F - 0.25g = (2 + 0.25)a$	**M1**	Newton's second law on either particle or for the system with correct masses; correct number of terms, allow sin/cos mix, allow sign errors. Allow with *their F*.
		A1	Both particle equations correct (with the same T) or system equation correct. Allow with *their F*. If *their a* direction is different to ours, allow if *their a* is consistently used e.g. $-2g\sin 30 + F + T = 2a'$ and $0.25g - T = 0.25a'$.
	$F = 0.3R = 0.3 \times 2g\cos 30\left[= 3\sqrt{3} = 5.1961\ldots\ldots\right]$	**M1**	Use of $F = 0.3R$, where R is a component of weight.
	Acceleration from A to $B = 1.02\ \text{m s}^{-2}$	**A1**	Solving for the acceleration from A to B. Allow $\frac{10 - 4\sqrt{3}}{3}$; AWRT 1.02 . May see $T = \frac{10 - \sqrt{3}}{3} = 2.7559\ldots$
		4	

Question	Answer	Marks	Guidance
7(a)(ii)	Use of suvat from A to B to get an equation in v^2 or v.	*M1	Using $u = 0$ and *their* $\lvert a \rvert$ from **(a)(i)** to get a positive v^2. E.g. $v^2 = 2 \times 0.8 \times (\textit{their}\ 1.02)$ or $v^2 = 2 \times (-0.8) \times (-\textit{their}\ 1.02)$.
	$v^2 = \left[\dfrac{80 - 32\sqrt{3}}{15}\right] = 1.64$ OR $v = 1.28$	A1	Not $v = 1.29$. Allow 2sf or better without wrong work, i.e. $v^2 = 1.6$ or $v = 1.3$.
	Find the acceleration from B to C: $2g \sin 30 - 0.25g = (2 + 0.25)a$	*M1	Resolving on both particles and eliminate T (if *their a* direction is different to ours, allow if *their a* is consistently used) OR for the system to get an equation in a only. Correct number of relevant terms, allow sin/cos mix, allow sign errors. For reference $a = \dfrac{10}{3}$ or 3.33. May see $T = \dfrac{10}{3}$.
	$v^2 = (\textit{their}\ 1.28)^2 + 2 \times \left(\textit{their}\ \dfrac{10}{3}\right) \times 1.2$	DM1	Use of suvat from B to C, allow *their* positive $a \neq g$ from **(a)(ii)** not *their a* from **(a)(i)** and *their* 1.28. Dependent on previous two marks.
	Velocity = 3.1(0) m s^{-1}	A1	AWRT 3.1(0) to 3sf.

Question	Answer	Marks	Guidance
7(a)(ii)	**Alternative Method for Question 7(a)(ii): using suvat in first stage and energy in second stage**		
	Use of suvat from A to B to get an equation in v^2 or v.	***M1**	Using *their* positive a from **(a)(i)** E.g. $v^2 = 2\times 0.8\times(\textit{their}\ 1.02)$.
	$v^2 = \left[\dfrac{80-32\sqrt{3}}{15}\right] = 1.64$ OR $v = 1.28$	**A1**	Allow 2sf or better, i.e. $v^2 = 1.6$ or $v = 1.3$.
	Change in PE $= \pm(2g\times 1.2\sin 30 - 0.25g\times 1.2)$ OR Change in KE $= \pm\left[\dfrac{1}{2}(2+0.25)v^2 - \dfrac{1}{2}(2+0.25)(\textit{their}\ 1.28)^2\right]$	**B1**	
	$\dfrac{1}{2}(2+0.25)v^2 - \dfrac{1}{2}(2+0.25)(\textit{their}\ 1.28)^2 = 2g\times 1.2\sin 30 - 0.25g\times 1.2$	**DM1**	Use of work-energy 6 terms; dimensionally correct. Allow sign errors. Allow sin/cos mix on PE. Dependent on previous M.
	Velocity = 3.1(0) m s^{-1}	**A1**	AWRT 3.1(0) to 3sf.

Question	Answer	Marks	Guidance
7(a)(ii)	**Alternative Method for Question 7(a)(ii): using energy for complete motion**		
	Change in PE $= \pm\left(2g \times 2\sin 30 - 0.25g \times 2\right)$	**B1**	
	Work done against friction $= 0.3 \times 2g\cos 30 \times 0.8$	**B1**	
	Change in KE $= \frac{1}{2}(2 + 0.25)v^2$	**B1**	
	$\frac{1}{2}(2 + 0.25)v^2 + 0.3 \times 2g\cos 30 \times 0.8 = \left(2g \times 2\sin 30 - 0.25g \times 2\right)$	**M1**	Use of work-energy 5 terms; dimensionally correct. Must be considering both particles. Allow sign errors. Allow sin/cos mix on PE and/or WD against friction.
	Velocity = 3.1(0) m s^{-1}	**A1**	AWRT 3.1(0) to 3sf.

Question	Answer	Marks	Guidance
7(a)(ii)	**Alternative Method for Question 7(a)(ii): using energy in two stages**		
	$\frac{1}{2}(2+0.25)v^2 + 0.3\times 2g\cos 30\times 0.8 = 2g\times 0.8\sin 30 - 0.25g\times 0.8$ OR $\frac{1}{2}\times 2\times v^2 + (their\ 2.7559\ldots)\times 0.8 + 0.3\times 2g\cos 30\times 0.8 = 2g\times 0.8\sin 30$ OR $\frac{1}{2}\times 0.25\times v^2 + 0.25g\times 0.8 = (their\ 2.7559\ldots)\times 0.8$	***M1**	Use of work-energy 5 terms; dimensionally correct. Allow sign errors. Allow sin/cos mix on PE. OR Use of work-energy 4 terms; dimensionally correct. Allow sign errors. Allow sin/cos mix on PE. OR Use of work-energy 3 terms; dimensionally correct. Allow sign errors.
	$v^2 = \left[\frac{80-32\sqrt{3}}{15}\right] = 1.64$ OR $v = 1.28$	**A1**	Allow 2sf or better, i.e. $v^2 = 1.6$ or $v = 1.3$.
	Change in PE $= \pm(2g\times 1.2\sin 30 - 0.25g\times 1.2)$ OR Change in KE $= \pm\left[\frac{1}{2}(2+0.25)v^2 - \frac{1}{2}(2+0.25)1.28^2\right]$	**B1**	
	$\frac{1}{2}(2+0.25)v^2 - \frac{1}{2}(2+0.25)1.28^2 = 2g\times 1.2\sin 30 - 0.25g\times 1.2$	**DM1**	Use of work-energy 6 terms; dimensionally correct. Allow sign errors. Allow sin/cos mix on PE. Dependent on previous 2 marks.
	Velocity = 3.1(0) m s^{-1}	**A1**	AWRT 3.1(0) to 3sf.
		5	

Question	Answer	Marks	Guidance
7(b)	$0.8 = 0 + \frac{1}{2} \times$ (*their* positive answer to **(a)(i)**) $\times t_1^2$ and solve for t_1 OR $0.8 = \frac{1}{2}$(0 + *their* positive 1.28 from **(a)(ii)**) t_1 and solve for t_1 OR (*their* positive 1.28 from **(a)(ii)**) = (*their* positive answer to **(a)(i)**) t_1 and solve for t_1	**M1**	Use of suvat from A to B to find t_1, using $s = 0.8$ and *their* positive $a \neq g$ from **(a)(i)**. Must get to $t_1 = \ldots$ OR using their positive 1.28 . OR using their positive $a \neq g$ from **(a)(i)** and positive 1.28 .
	1.2 = (*their* 1.28 from **(a)(ii)**) $t_2 + \frac{1}{2} \times \left(\text{their } \frac{10}{3} \right) \times t_2^2$ and solve for t_2 OR $1.2 = \frac{1}{2}$ ((*their* 1.28 from **(a)(ii)**) + (*their* answer to **(a)(ii)**)) t_2 and solve for t_2 OR (*their* answer to **(a)(ii)**) = (*their* 1.28 from **(a)(ii)**) $+ \left(\text{their } \frac{10}{3} \right) t_2$ and solve for t_2	**M1**	Use of suvat from B to C to find t_2, using $s = 1.2$ and *their* positive $a \neq g$ from **(a)(ii)** (not *their a* from **(a)(i)**) and *their* 1.28 which would lead to a positive t_2 value. Must get to $t_2 = \ldots$ OR using *their* 1.28 and/or *their* answer to **(a)(ii)** which would lead to a positive t_2 value. OR using *their* 1.28 and/or *their* answer to **(a)(ii)** and *their* $a \neq g$ from **(a)(ii)** (not *their a* from **(a)(i)**) which would lead to a positive t_2 value.
	$t_1 = 1.25$ or $t_2 = 0.547$	**A1**	These can be seen as an expression. Allow $t_1 = \frac{0.8}{0.64}$ $t_2 = \frac{1.2}{2.19}$ OE. Allow 2sf or better, e.g. $t_1 = 1.3$ or $t_1 = 0.55$.
	Total time = 1.8(0) s	**A1**	WWW. AWRT 1.8(0) to 3sf.
		4	