Mark Scheme (Results)

January 2025

Pearson Edexcel International Advanced Level

In Mechanics M1 (WME01) Paper 01

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL IAL MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: Method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations
These are some of the traditional marking abbreviations that will appear in the mark schemes and can be used if you are using the annotation facility on ePEN.

- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- d… or dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- * The answer is printed on the paper or ag- answer given
- $\lfloor$ or d… The second mark is dependent on gaining the first mark

4. All A marks are ‘correct answer only’ (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected. If you are using the annotation facility on ePEN, indicate this action by ‘MR’ in the body of the script.

6. If a candidate makes more than one attempt at any question:
    - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
    - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

General Principles for Mechanics Marking

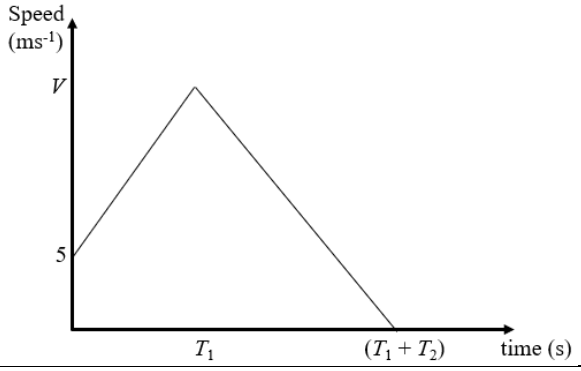
(NB specific mark schemes may sometimes override these general principles)

- Rules for M marks:
  - correct no. of terms
  - dimensionally correct
  - all terms that need resolving (i.e. multiplied by cos or sin) are resolved.
- Omission or extra g in a resolution is an accuracy error not method error.
- Omission of mass from a resolution is a method error.
- Omission of a length from a moments equation is a method error.
- Omission of units or incorrect units is not (usually) counted as an accuracy error.
- DM indicates a dependent method mark, i.e. one that can only be awarded if a previous specified method mark has been awarded.
- Any numerical answer which comes from use of g = 9.8 should be given to 2 or 3 SF.
- Use of g = 9.81 should be penalised once per (complete) question.
  - N.B. Over-accuracy or under-accuracy of correct answers should only be penalised *once* per complete question. However, premature approximation should be penalised every time it occurs.
- Marks must be entered in the same order as they appear on the mark scheme.
- In all cases, if the candidate clearly labels their working under a particular part of a question i.e. (a) or (b) or (c)…then that working can only score marks for that part of the question.
- Accept column vectors in all cases.
- Misreads – if a misread does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, bearing in mind that after a misread, the subsequent A marks affected are treated as A ft

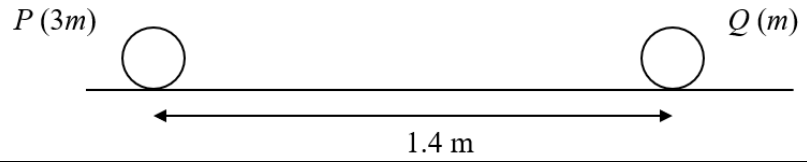
Mechanics Abbreviations

M(A)	Taking moments about A
N2L	Newton's Second Law (Equation of Motion)
NEL	Newton's Experimental Law (Newton's Law of Impact)
HL	Hooke's Law
SHM	Simple harmonic motion
PCLM	Principle of conservation of linear momentum
RHS	Right hand side
LHS	Left hand side

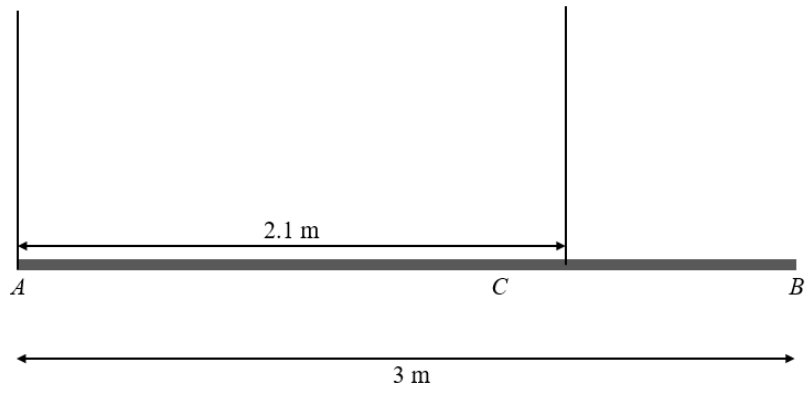
QUESTION NUMBER	SCHEME	MARKS
1(a)	Resultant force $(6\mathbf{i} + 8\mathbf{j})+(-16\mathbf{i}+2\mathbf{j})+(-2\mathbf{i}+8\mathbf{j})$	M1
	N2L $-12\mathbf{i} +18\ \mathbf{j} = 2.5\mathbf{a}$ oe **OR** $\sqrt{((-)12)^2 +18^2} = 2.5a$ oe	M1
	Pythagoras $\sqrt{((-)4.8)^2 +(7.2)^2}$ **OR** $\sqrt{((-)12)^2 +18^2}$	M1
	8.7 or better (m s^{-2})	A1
		(4)
1(b)	$-12\mathbf{i} +18\mathbf{j}+ p\mathbf{i} + p\mathbf{j} = (-12+p)\mathbf{i} + (18+p)\mathbf{j}$	M1
	$\frac{-12+p}{18+p}=\frac{7}{2}$	M1 A1
	$p = -30$	A1
		(4)
		(8)
	Notes for Question 1	
	Accept column vectors throughout	
1(a)		
M1	Find the resultant force by finding the sum of $\mathbf{F}_1$, $\mathbf{F}_2$ and $\mathbf{F}_3$ **i**'s and **j**'s do NOT need collecting	
M1	Use of N2L, in vector or scalar form, with <u>their resultant</u> force	
M1	Use of Pythagoras to find a magnitude. This may be magnitude of acceleration or magnitude of their resultant force if carried out before N2L.	
A1	Correct answer from correct working. Exact value is $\frac{12}{5}\sqrt{13}$, accept 8.7 or better. (8.653323061..)	
1(b)		
M1	Find the resultant **force** AND collect **i**'s and **j**'s. Can be scored for a clear **attempt** at adding $p\mathbf{i} + p\mathbf{j}$ to their possibly incorrect resultant from (a)	
M1	Use direction $7\mathbf{i} + 2\mathbf{j}$ with their **i** and **j** components of their resultant **force** to form a ratio equation in p ONLY. Condone a sign error and reciprocal, but must be using 7 and 2. May use $(-12+p)\mathbf{i} + (18+p)\mathbf{j} = \lambda(7\mathbf{i}+2\mathbf{j})$, equate components AND eliminate $\lambda (= -6)$ to form an equation in p ONLY.	
A1	Correct unsimplified equation in p ONLY.	
A1	Correct answer.	

QUESTION NUMBER	SCHEME	MARKS
2(a)		B1 shape B1 time labels B1 speed labels
		(3)
2(b)(i)	$132 = \frac{(5+V)T_1}{2}$ **OR** $132 = 5T_1 + \frac{1}{2}T_1(V-5)$	M1
	$T_1 = \frac{264}{5+V}$ oe	A1
2(b)(ii)	$136 = \frac{VT_2}{2}$	M1
	$T_2 = \frac{272}{V}$ oe	A1
		(4)
2(c)	$\frac{264}{5+V} + \frac{272}{V} = 28$	M1
	$(28V^2 - 396V - 1360 = 0$ **OR** $7V^2 - 99V - 340 = 0)$	
	$V = 17$ only	A1
		(2)
2(d)	Deceleration = $\frac{\textit{their } V}{\textit{their } T_2}$ **OR** $\frac{(\textit{their } V)^2}{272}$	M1
	$\frac{17}{16}$ oe $= 1.0625$ Accept 1.1 or better (m s^{-2})	A1
		(2)
		(11)
	Notes for Question 2	
	N.B. If you think a candidate has misread the question and consistently uses T_2 as the time from *A* to *C*, send to Review.	
	Allow use of t_1 and t_2 instead of T_1 and T_2 throughout.	
2(a)		
B1	Correct graph shape. Must start on the vertical axis and not at the origin and finish on the *t*-axis. B0 if they have any extra **continuous** lines.	
B1	Correct time labels. Accept delineators (B0 if delineators missing)	

B1	Correct speed labels.	
2(b)(i)		
M1	Complete method using 132 to form an equation in V and T_1. May use area or *suvat* equation(s). **N.B**. M0 for $132 = \frac{(5+5+V)T_1}{2}$	
A1	Correct expression for T_1.	
2(b)(ii)		
M1	Complete method using 136 to form an equation in V and T_2. May use area or *suvat* equation(s). **N.B.** Allow a correct method based on their graph IF IT HELPS THE CANDIDATE, but must produce an equation in V and T_2 **only.** **e.g.** $136 = \frac{1}{2}V(T_2 - T_1)$ **with T_1 then replaced in terms of V**	
A1	Correct expression for T_2.	
2(c)		
M1	Use 28 and **sums** their expressions for T_1 and T_2 to form an equation in V only. **N.B.** Allow a restart for either T_1 or T_2 or both.	
A1	Correct answer for V. If seen, a negative value ($\frac{-20}{7}$) should be rejected.	
2(d)		
M1	Use their V and their T_2 (or their V in the alternative) to find an **expression** for the deceleration (allow minus sign).	
A1	Correct deceleration must be positive. 1.1 or better. The exact answer is $\frac{17}{16}$, 1.0625.	

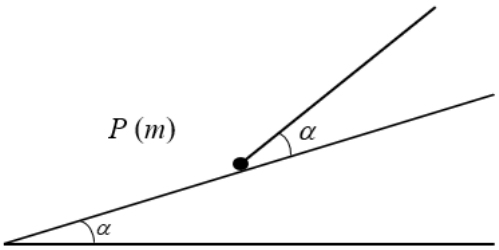
QUESTION NUMBER	SCHEME	MARKS
3		
3(a)	$\lambda = 3m(5-0)$	M1
	$= 15m$	A1
		(2)
3(b)	$2.5^2 = 5^2 + 2a(1.4)$ **OR** $5^2 = 2.5^2 + 2a(1.4)$	M1 A1
	$R = 3mg$	B1
	Use of $F = \mu R$	M1
	N2L $-\mu(3mg) = 3m \times a$ or just $-\mu g = a$	M1 A1
	$\mu = 0.68$ or 0.683	A1
		(7)
3(c)	$3m(2.5) + m(0) = \pm\ 3mv + m(2.1)$ **OR** $3m(\pm v - (-2.5)) = m \times 2.1$	M1 A1
	$v = \pm\ 1.8$ so speed is 1.8 (m s^{-1})	A1
		(3)
		(12)
	Notes for Question 3	
3(a)		
M1	Use of $I = \pm m\,(v-u)$ with $3m$ and 5. May not see $u = 0$. M0 if g is included or m missing.	
A1	Correct answer. **N.B.** $\lambda =$ NOT NEEDED.	
3(b)		
M1	Complete method, using *suvat*, to find an equation in a only. Ignore sign errors.	
A1	Correct unsimplified equation in a only. (the exact value for a is $\frac{-375}{56} = -6.6964..$)	
B1	Correct expression for R seen.	
M1	Use $F = \mu R$ for **their** R (must have found an R)	
M1	Correct method using N2L to give an equation in (m), μ and a. Must have correct number of forces and either $3m$ or m on BOTH sides of the equation or on neither side. Allow missing g.	
A1	Correct unsimplified equation in m, μ and a **N.B.** a does NOT need to be substituted for this mark but it must be consistent (in direction) with the previous *suvat* equation. i.e. it must lead to a POSITIVE value for μ.	
A1	Correct answer for μ to 2 or 3 sf.	
3(c)		

M1	Dimensionally correct CLM equation in v ONLY with correct number of terms and correct pairings of masses and velocities. Allow consistent extra g's. Ignore sign errors. **OR** equate impulses to give a dimensionally correct equation in v ONLY**.** Allow consistent extra g's. Ignore sign errors.	
A1	Correct unsimplified equation.	
A1	Correct speed, must be positive.	

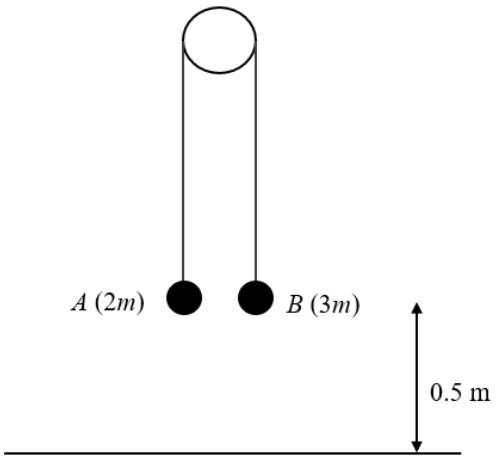
QUESTION NUMBER	SCHEME	MARKS
4		
4(a)	M(A): $350\times 2.1 = W\times 1.5$	M1 A1
	$W = 490$ *	A1*
		(3)
4(b)	M(A): $(600\times 2.1) = (490\times 1.5) + (210\times d)$	M1 A1
	$d = 2.5$	A1
		(3)
4(c)	Tension at A = 0	B1
	M(C): $490\times 0.6 = X\times 0.9$	M1 A1
	$X = \frac{980}{3} = 326.6666\ldots$ (330 or better)	A1
		(4)
		(10)
	Notes for Question 4	
4(a)		
M1	Uses a complete method to form an equation in W only. Dimensionally correct and the correct number of terms. Extra g is an A error. May use two equations and eliminate T_A (= 140) G is the centre of the rod Vert: $T_A + 350 = W$ M(C): $T_A\times 2.1 = W\times 0.6$ M(G): $T_A\times 1.5 = 350\times 0.6$ M(B): $T_A\times 3 + (350\times 0.9) = W\times 1.5$	
A1	Correct unsimplified equation in W only.	
A1*	Cso.	
4(b)		
M1	Uses a complete method to form an equation in d only. Dimensionally correct and the correct number of terms. Extra g is an A error.	

	M(A): $(600\times 2.1)=(490\times 1.5)+(210\times d)$ May use two equations and eliminate T_A (=100) G is the centre of the rod and P is the position of the particle Vert: $T_A+600=490+210$ M(C): $(T_A\times 2.1)=(490\times 0.6)+210(2.1-d)$ M(G): $(T_A\times 1.5)=(600\times 0.6)+210(1.5-d)$ M(P): $(T_A\times d)+490(1.5-d)=600(2.1-d)$	
A1	Correct unsimplified equation in d only	
A1	Correct answer	
4(c)		
B1	Tension at A is 0, seen or implied by the M mark.	
M1	Uses a complete method to form an equation in X only. Dimensionally correct and the correct number of terms. Extra g is an A error. M0 if tension at A is never 0. M(C): $490\times 0.6=X\times 0.9$ May use other equations and eliminate T_C $(=\frac{2450}{3}=816.666..)$ Vert: $T_C=490+X$ M(A): $(T_C\times 2.1)=(490\times 1.5)+(X\times 3)$ M(G): $T_C\times 0.6=X\times 1.5$ M(B): $T_C\times 0.9=490\times 1.5$	
A1	Correct unsimplified equation in X only.	
A1	Correct answer $\frac{980}{3}$ oe, 330 or better (326.666…)	

QUESTION NUMBER	SCHEME	MARKS
5(a)	$\dfrac{(10\mathbf{i}-3\mathbf{j})-(-2\mathbf{i}+5\mathbf{j})}{8}$	M1 A1
	$1.5\mathbf{i}-\mathbf{j}$ (m s^{-1})	A1
		(3)
5(b)	$(-2\mathbf{i}+5\mathbf{j})+6\mathbf{v}$ OR $(10\mathbf{i}-3\mathbf{j})-2\mathbf{v}$	M1
	Correct unsimplified expression (= $(7\mathbf{i}-\mathbf{j})$)	A1
	$\lvert BT\rvert=\sqrt{(13-7)^2+(-5--1)^2}$	M1
	= $\sqrt{52}$, $2\sqrt{13}$ or 7.2 or better (m)	A1
		(4)
		(7)
	Notes for Question 5	
	Accept column vectors throughout	
5(a)		
M1	Use of displacement ÷ time. The terms in the numerator may be either way round but it must be a difference. M0 if they use 9 instead of 8	
A1	Correct unsimplified expression for **v**	
A1	Correct velocity, accept column vector $\begin{pmatrix}1.5\\-1\end{pmatrix}$ Ignore (velocity) = $=\sqrt{1.5^2+(-1)^2}$ etc	
5(b)		
M1	Complete method using their velocity to find the position of *B* at *t* = 7. They may find the position at *t* = 0 ($(-3.5\mathbf{i}+6\mathbf{j})$) first then add $7\mathbf{v}$	
A1	Correct unsimplified expression. Note that with correct **v** this simplifies to $(7\mathbf{i}-\mathbf{j})$	
M1	Use Pythagoras to find the distance between their position of *B* and *T*, allow slips. **N.B.** Must have used either $(-2\mathbf{i}+5\mathbf{j})+k\mathbf{v}$ or $(10\mathbf{i}-3\mathbf{j})+k\mathbf{v}$ where *k* is a non-zero integer, to find the position vector of *B*	
A1	Correct answer. Accept 7.2 (m) or better, exact value $2\sqrt{13}, \sqrt{52}$	

QUESTION NUMBER	SCHEME	MARKS
6		
6(a)	$(F =)\ 0.75mg\cos\alpha - mg\sin\alpha$ **N.B. Accept** $\frac{1}{2}(mg\cos\alpha - 0.75mg\sin\alpha)$	M1 A1 A1
		(3)
6(b)	$R = mg\cos\alpha - 0.75mg\sin\alpha$	M1 A1
	Use of (max) $F = \frac{1}{2}R$	B1
	$0.75mg\cos\alpha - mg\sin\alpha = \frac{1}{2}(mg\cos\alpha - 0.75mg\sin\alpha)$	M1 A1
	e.g. $(0.75mg - \frac{1}{2}mg)\cos\alpha = (mg - \frac{1}{2}\times 0.75mg)\sin\alpha$ $\tan\alpha = \frac{2}{5}$ *	A1*
		(6)
6(c)		
	(Finds max friction =) $\frac{1}{2}(mg\cos\alpha)$ (and weight component down the plane =) $mg\sin\alpha$	M1
	Sub for α AND compare: (max friction) $= \frac{1}{2}mg\times\frac{5}{\sqrt{29}} = \frac{5\sqrt{29}mg}{58} = 0.4642..mg$ (wt cpt) $= mg\times\frac{2}{\sqrt{29}} = \frac{4\sqrt{29}mg}{58} = 0.371..mg$ AND e.g. $0.464mg > 0.371mg$ **N.B.** Must see an **inequality or a difference** i.e words are not sufficient. **OR: use** $\tan\alpha = \frac{2}{5}$, e.g. $mg\sin\alpha = \frac{2}{5}mg\cos\alpha < \frac{1}{2}(mg\cos\alpha)$ **OR**: At rest if $\frac{1}{2}(mg\cos\alpha) > mg\sin\alpha$ oe	A1

	$\frac{1}{2} > \tan\alpha$	
	Conclusion: since 0.4642..oe > 0.371..oe the box remains at rest. **OR:** $\frac{1}{2} > \frac{2}{5}$ so the box remains at rest.	A1
		(3)
		(12)
	Notes for Question 6	
6(a)		
M1	Resolve parallel to the plane to give an expression in *m*, *g* and α only.Correct no. of terms, dimensionally correct, any forces that should be resolved must be resolved, condone sign errors and sin/cos confusion.	
A1	Unsimplified expression in *m*, *g* and α only, with at most one error (if **both** signs are wrong treat as one error) Sin/cos reversed is ONE error. Omission of *g*'s is ONE error.	
A1	Correct expression	
6(b)		
M1	Resolve perpendicular to the plane. Correct no. of terms, dimensionally correct, any forces that should be resolved must be resolved, condone sign errors and sin/cos confusion.	
A1	Correct unsimplified equation.	
B1	Use of $\max F = \frac{1}{2}R$	
M1	Eliminate *F* and *R* to form an equation in *mg* and α **with correct no. of terms**	
A1	Correct equation in *mg* and α	
A1*	cso Complete method to reach the given answer from sufficient working, must have collected the $\sin\alpha$ terms and the $\cos\alpha$ terms, before proceeding to the given answer OR collect $\tan\alpha$ terms if they divide through by $\cos\alpha$ first.	
6(c)		
M1	Finds new max friction and weight component down the plane. Condone sign errors and sin/cos confusion. M0 if no new *R* is used.	
A1	Correct expressions with α replaced AND compared or difference found (this could be done by writing down an equation of motion parallel to the plane) **OR: if** α not replaced, correct inequality in $\tan\alpha$ only.	
A1	Correct conclusion with valid reason.	

QUESTION NUMBER	SCHEME	MARKS
7		
7(a)	First equation of motion for either particle or whole system. For *A:* $T - 2mg = 2ma$ For *B*: $3mg - T = 3ma$ For system: $3mg - 2mg = 5ma$	M1 A1
	Second equation of motion for either particle or whole system.	M1 A1
	$T = \frac{12mg}{5}$ or $2.4mg$	A1
		(5)
7(b)	Acceleration = $\frac{g}{5}$ oe (must be used in (b))	B1
	$v^2 = 0^2 + 2 \times their\ a \times (0.5)$	M1
	$v^2 = 2 \times \frac{g}{5} \times 0.5 \quad (=1.96)$	A1
	$v = 1.4$ (m s^{-1})	A1
		(4)
7(c)	Equation for time to travel the first 0.5m e.g $0.5 = 0 + \frac{1}{2}\left(\frac{g}{5}\right)t^2$ **OR** $0.5 = \left(\frac{0+1.4}{2}\right)t$	M1 A1
	Equation for time for which *A* is moving under gravity $0.06 = '1.4't + \frac{1}{2}(-g)t^2$	M1 A1**ft**

	$t = 0.0525069\ldots \quad \left(\frac{5-\sqrt{10}}{35}\right)$	A1
	Total time = 0.05250. + 0.71428.. = 0.77 or 0.767 (s)	A1
		(6)
		(15)
	Notes for Question 7	
7(a)	**N.B.** If *m*'s consistently missing, award M marks only.	
M1	Form an equation of motion for a particle or the whole system. Correct no. of terms, dimensionally correct, condone sign errors. For *A:* $T - 2mg = 2ma$ For *B*: $3mg - T = 3ma$ For system: $3mg - 2mg = 5ma$	
A1	Correct equation.	
M1	Form second equation of motion. Correct no. of terms, dimensionally correct, condone sign errors.	
A1	Correct equation.	
A1	Correct expression for tension **N.B.** must be *kmg*	
7(b)		
B1	Correct acceleration.	
M1	Complete method to find an equation in *v* only. Must use their acceleration. M0 if they assume that $a = 9.8$	
A1	Correct equation in *v* only.	
A1	Cao **N.B.** 7/5 is A0.	
7(c)		
M1	Complete method to find an equation for the time taken to travel first 0.5m. Must use their acceleration for the pulley system.	
A1	Correct equation in *t* only. Note that solving this equation gives $t = 0.71$ or 0.714 (5/7)	
M1	Complete method to find an equation in *t* (time to move a distance 0.06 m) only, using *g* for acceleration. Allow M1 if 0.56 m used but M0 for any other distance or if they use $u = 0$ or $v = 0$.	
A1ft	Correct equation in *t* only, ft on answer to (b).	
A1	If they stop here, then it must be $t = 0.053$ or 0.0525 (If seen, 0.233 should be rejected.) However, this A mark can be implied by a correct final answer.	
A1	Complete the solution to find the correct total time 2/3 sf	

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