GradeMax

Pearson

Mark Scheme (Results)

January 2026

Pearson Edexcel International Advanced Level in Mechanics M2
WME02/01

GradeMax

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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

- ⌐ 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:
   a) If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   b) If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

Ignore wrong working or incorrect statements following a correct answer

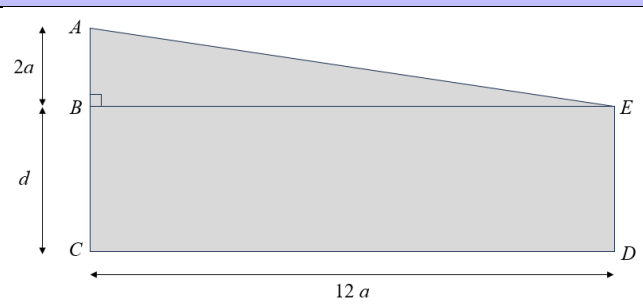
General Principles for Mechanics Marking

*(**N.B.** specific mark schemes may sometimes override these general principles)*

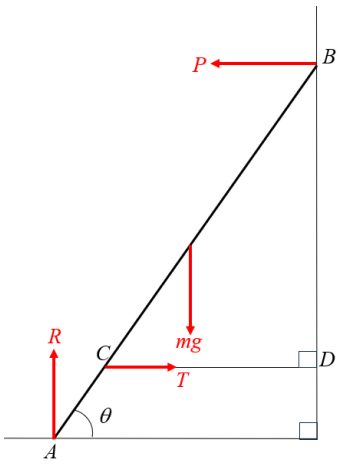
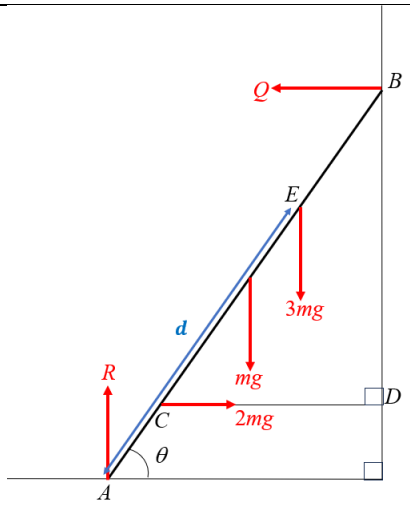
- Rules for M marks:
  - correct number of terms
  - dimensionally correct
  - all terms that need resolving (i.e. *multiplied* by cos or sin) are resolved
  - only terms that need resolving are resolved
  - +/– errors are condoned
  - sin/cos confusion is condoned
- Omission or extra g in a resolution 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(s) has been awarded.
- Any numerical answer which comes from use of $g = 9.8$ should be given as a decimal 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

Question number	Scheme	Marks
1		
1(a)	Use of $P=Fv$ $\left(D=\dfrac{20\,000}{\lambda}\right)$	M1
	Equation of motion $D-1200g\sin\theta-26\lambda=1200a$	M1
	$\dfrac{20000}{\lambda}-1200g\dfrac{1}{14}-26\lambda=1200(0.75)$ $\left(26\lambda^2+1740\lambda-20000=0\right)$	A1
	$\lambda=10\ \Rightarrow\ R=260$*	A1*
		(4)
	ALTERNATIVE using *R*	
	Use of $P=Fv$ $\left(D=\dfrac{20\,000}{\lambda}\right)$ and R=26λ to give $D=\dfrac{20000}{\frac{R}{26}}=\dfrac{520\,000}{R}$	M1
	Equation of motion $D-1200g\sin\theta-R=1200a$	M1
	$\dfrac{520\,000}{R}-1200g\times\dfrac{1}{14}-R=1200a$ $\left(R^2+1740R-520\,000=0\right)$	A1
	R=260*	A1*
1(b)	Equation of motion	M1
	$D'+1200g\sin\theta-260=1200(1.8)$	A1
	$\dfrac{P}{12}+\dfrac{1200g}{14}-260=1200(1.8)$	A1
	$P=19000$	A1
		(4)
		(8)

	Notes for question	
(a)		
M1	Use of $P = Fv$, $\left(D = \frac{20\,000}{\lambda} \right)$	
M1	Equation of motion. Dimensionally correct, correct number of terms, condone sin/cos confusion and sign errors. Trig and *D* do not need to be replaced. Allow *R* for 26λ	
A1	Correct unsimplified equation in λ only or λ and *g*.	
A1*	Given answer obtained from correct working. Must see $\lambda = 10$ A0 if *R*=260 appears without seeing $\lambda = 10$	
	ALTERNATIVE	
M1	Use of $P = Fv$ and and R=26λ to form expression for *D*.	
M1	Equation of motion. Dimensionally correct, correct number of terms, condone sin/cos confusion and sign errors. Trig and *D* do not need to be replaced	
A1	Correct unsimplified equation in *R* only or *R* and *g*.	
A1*	Correct answer obtained from correct working,	
(b)		
M1	Equation of motion. Dimensionally correct, correct number of terms, condone sin/cos confusion and sign errors.	
A1	A correct unsimplified equation of motion. Trig does not need to be replaced but does for final A mark.	
A1	Replace trig in equation of motion and use $\frac{P}{12}$ to produce a correct unsimplified equation in *P* only.	
A1	Correct answer, 2/3sf only. Accept *P* = 19 000 only	

Question number	Scheme	Marks
2		
2(a)	<table><tr><td></td><td>Mass ratio</td><td>Distance from AC</td></tr><tr><td>Triangle</td><td>$12a^2$</td><td>$4a$</td></tr><tr><td>Rectangle</td><td>$12ad$</td><td>$6a$</td></tr></table>	B1 mass B1 dist
	Moments about AC or a parallel axis	M1
	$(12a^2 \times 4a) + (12ad \times 6a) = (12a^2 + 12ad)\bar{x}$	A1
	$\bar{x} = \dfrac{2a(2a+3d)}{(a+d)}$ *	A1*
		(5)
2(b)	$\bar{x} = \dfrac{28}{5}a$	B1
	Moments equation about A	M1
	$\left(W \times \dfrac{28}{5}a\right) + \left(\dfrac{W}{2} \times 12a\right) = F \times 6a$	A1
	$F = \dfrac{29}{15}W$	A1
		(4)
		(9)

	Notes for question	
(a)		
B1	Correct mass ratios	
B1	Correct distances from AC.	
M1	Moments taken about AC or a parallel axis. Dimensionally correct equation. All terms required.	
A1	Correct unsimplified equation. If mass ratios are simplified before taking moments: $4a^2 + 6ad = (a+d)\bar{x}$ Incorrect use of brackets will be penalised in final A mark.	
A1*	Correctly obtain given answer from completely correct working, including use of brackets. At least one stage of simplification must be seen in working. Final answer must be a correctly factorised fraction eg allow $(d+a)$ for $((a+d)$ etc	
(b)		
B1	$\bar{x} = \frac{28}{5}a$ .This mark can be awarded for a correct substitution of 4a in to a $\bar{x} = \frac{2a(2a+3d)}{(a+d)}$. ISW subsequent working if incorrect result occurs.	
M1	Complete method to find an equation in F, W (and a) Dimensionally correct equation. All terms required. $d = 4a$ must be substituted.	
A1	Correct unsimplified equation.	
A1	Correct answer, accept $1.9W$ or better 1. 9333..W accept $\frac{58}{30}W$	
	N.B. In part (b) If $d=4a$ is not used, then zero marks in this part.	

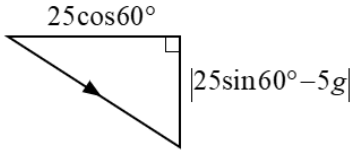
Question number	Scheme	Marks
3		
3(a)	$P = T$ or $R = mg$	B1
	Moments equation	M1
	E.g. M(A) $(P \times 10a\sin\theta) = (mg \times 5a\cos\theta) + (T \times 2a\sin\theta)$ **with *P* and or *R* substituted**	A1
	$\tan\theta = \dfrac{5mg}{8T}$ *	A1*
		(4)
3(b)		
	$Q = 2mg$ or $R = 4mg$	B1
	Moments equation	M1
	e.g. M(A) $(Q \times 10a\sin\theta) = (3mg \times d\cos\theta) + (mg \times 5a\cos\theta) + (2mg \times 2a\sin\theta)$ Q and/or R do not need to be substituted for **this mark** but $T = 2mg$ does.	A1
	Q and/or R substituted to produce a correct equation in in d, a and (g) only	A1
	$d = 5.4a$ or $5.44a$ (m)	A1
		(5)
		(9)

	Notes for question **NB for the moment equations in this question, ignore the stated centre of the moment and mark the equation.**	
(a)		
B1	Resolves horizontally or vertically	
M1	A complete method to obtain an unsimplified equation in T, m, g and θ (allow a as well) Requires all terms and no extras. Dimensionally correct. Condone sign errors and sin/cos confusion. P and/or R must be substituted	
A1	Correct unsimplified equation in T, m, g and θ Other moments equations include: $[\mathrm{M}(C)]\quad 2aR\cos\theta+3amg\cos\theta=8aP\sin\theta\Rightarrow 2mg+3mg=8aT\tan\theta$ $[\mathrm{M}(G)]\quad 5aR\cos\theta=5aP\sin\theta+3aT\sin\theta$ $[\mathrm{M}(B)]\quad 10aR\cos\theta=5amg\cos\theta+8aT\sin\theta$ $[\mathrm{M}(D)]\quad 8aP\sin\theta+5amg\cos\theta=10R\cos\theta$ $[\mathrm{M}(\text{corner})]\quad 10aR\cos\theta+2aT\sin\theta=5amg\cos\theta+10aP\sin\theta$ $[M(PR\text{ intersect})]\ 8aT\sin\theta=5amg\cos\theta$	
A1*	Obtain given answer from correct working.	
(b)	**N.B. In part (b), allow use of inequalities for first 4 marks but must have equality for final A mark**	
B1	Resolves horizontally or vertically or parallel or perpendicular to rod. Parallel: $R\sin\theta+2mg\sin\theta=mg\sin\theta+3mg\sin\theta+Q\cos\theta$ Perp: $Q\sin\theta+R\cos\theta=2mg\sin\theta+mg\cos\theta+3mg\cos\theta$	
M1	Form a **moments** equation. Requires all terms and no extras. Dimensionally correct. Condone sign errors and sin/cos confusion. T=$2mg$ (and W=mg)must be used for M mark. May be seen later. Other relevant equations include: $[\mathrm{M}(C)]\quad 2aR\cos\theta+3amg\cos\theta+3mg(d-2a)\cos\theta=8aQ\sin\theta$ $[\mathrm{M}(G)]\quad 5aR\cos\theta+3mg(d-5a)\cos\theta=2mg3a\sin\theta+5Qa\sin\theta$ $[\mathrm{M}(E)]\quad dR\cos\theta=2mg(d-2a)\sin\theta+mg(d-5a)\cos\theta+Q(10a-d)\sin\theta$ $[\mathrm{M}(B)]\quad 3mg\times(10a-d)\cos\theta+mg\times5a\cos\theta+2mg\times8a\sin\theta=R\times10a\cos\theta$ $[\mathrm{M}(D)]\quad 10aR\cos\theta+8Qa\sin\theta=5amg\cos\theta+3mg(10a-d)\cos\theta$ $[\mathrm{M}(\text{corner})]\quad 10aR\cos\theta+2mg2a\sin\theta=5amg\cos\theta+3mg(10a-d)\cos\theta+10aQ\sin\theta$ $[\mathrm{M}(PR\text{intersect})]\ 8a\times2mg\sin\theta=5amg\cos\theta+3mgd\cos\theta$	
A1	Correct equation with at most one error, allow Q and R but T must be substituted.	
A1	Correct equation in d, a and (g) only ie Q and/or R must be substituted.	
A1	Correct answer. Accept $5.4a$ or better, exact answer is $\frac{49}{9}a$, $5.444\ldots a$	

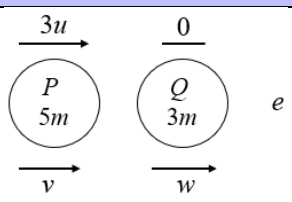
Question number	Scheme	Marks
4	Accept column vectors throughout the question	
4(a)	Solves at least one of • $14+6t-25\sqrt{t}=0$ • $7+8t-30\sqrt{t}=0$	M1
	Find $t=\frac{49}{4}$ from at least one equation	A1
	Both equations used to conclude $t=\frac{49}{4}$ only	A1
		(3)
4(b)	Differentiates both components	M1
	$\mathbf{a}=\left(6-\frac{25}{2}t^{-\frac{1}{2}}\right)\mathbf{i}+\left(8-15t^{-\frac{1}{2}}\right)\mathbf{j}$	A1
	Use of components to form a relevant equation in t. Scalar product gives: $\begin{pmatrix}6-\frac{25}{2}t^{-\frac{1}{2}}\\8-15t^{-\frac{1}{2}}\end{pmatrix}\bullet\begin{pmatrix}2\\-1\end{pmatrix}=0$ $\Rightarrow \quad 2\left(6-\frac{25}{2}t^{-\frac{1}{2}}\right)-\left(8-15t^{-\frac{1}{2}}\right)=0$	M1
	$t=6.25$	A1
		(4)
4(c)	Integrates both components	M1
	$\mathbf{s}=\left(14t+3t^2-\frac{50}{3}t^{\frac{3}{2}}\right)\mathbf{i}+\left(7t+4t^2-20t^{\frac{3}{2}}\right)\mathbf{j}$ (+ constant vector)	A1
	Use $t=1$ and $\mathbf{s}=\frac{1}{3}\mathbf{i}-7\mathbf{j}$ to find	M1
	$\mathbf{s}=\left(14t+3t^2-\frac{50}{3}t^{\frac{3}{2}}\right)\mathbf{i}+\left(7t+4t^2-20t^{\frac{3}{2}}+2\right)\mathbf{j}$	A1
	Complete method to find OP $\sqrt{\left(14(4)+3(4)^2-\frac{50}{3}(4)^{\frac{3}{2}}\right)^2+\left(7(4)+4(4)^2-20(4)^{\frac{3}{2}}+2\right)^2}$	M1
	$OP=72$ or better	A1
		(6)

(c) ALT 1	Last 4 marks in (c) using definite integration	
	Use of correct limits in integrated expression to find displacement, $1 \leqslant t \leqslant 4$ $\left[\left(14t+3t^2-\frac{50}{3}t^{\frac{3}{2}}\right)\mathbf{i}+\left(7t+4t^2-20t^{\frac{3}{2}}\right)\mathbf{j}\right]_1^4=-\frac{89}{3}\mathbf{i}-59\mathbf{j}$	M1 A1
	Complete method to find OP $OP=\sqrt{\left(-\frac{88}{3}\right)^2+(-66)^2}$	M1
	$OP = 72$ or better	A1
		(6)
		(13)
	Notes for question	
(a)		
M1	Solves for t or $\sqrt{t}$ in either **i** or **j** component equal to zero.	
A1	Find $t=\frac{49}{4}$ from at least one equation. Using i components: $t=\frac{49}{4}\left(\text{and } \frac{4}{9}\right)$ or Using j components, $t=\frac{49}{4}\left(\text{and } \frac{1}{16}\right)$ **N.B. Equating components is M0** **Adding components and equating to 0 is M0**	
A1	Uses both equations to conclude $t=\frac{49}{4}$ **(only).** May solve both equations or solve one and using verification.	
	Special case	
	Find magnitude of vector **and** equate to zero **and** solve for t	M1
	Find $t=\frac{49}{4}$ as one possible solution	A1
	For final A mark must obtain correct value of t and dismiss other cases. Equation $100P^4-780P^3+1805P^2-1120P+245=0$ Where $P=\sqrt{t} \Rightarrow P=\frac{7}{2}, t=\frac{49}{4}$	A1

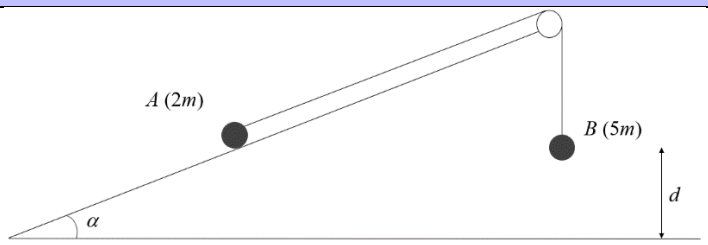
(b)		
M1	Differentiates both components of **v**. In each component, at least one power must decrease by 1.	
A1	Correct expression for acceleration, seen or implied.	
M1	Use the components of acceleration to form a relevant equation in t only. May use the parallel vector $\mathbf{i}+2\mathbf{j}$ to form an equation in t only. For example, $\dfrac{\left(6-\frac{25}{2}t^{-\frac{1}{2}}\right)}{8-15t^{-\frac{1}{2}}}=\dfrac{1}{2}$ or $\left(6-\frac{25}{2}t^{-\frac{1}{2}}\right)\mathbf{i}+\left(8-15t^{-\frac{1}{2}}\right)\mathbf{j}=\lambda(\mathbf{i}+2\mathbf{j})$ to form simultaneous equations with λ eliminated. Must be correct ratio M0 if using $-\frac{1}{2}, \frac{2}{1}$ or $\lambda(\mathbf{i}-2\mathbf{j})$	
A1	Correct answer, accept 6.3	
(c)		
M1	Integrates both components of **v**. In each component, at least one power must increase by 1.	
A1	Correct unsimplified expression. Allow with no constant(s) of integration.	
M1	Use $t = 1$ and $s=\frac{1}{3}\mathbf{i}-7\mathbf{j}$, to find an expression for position.	
A1	Correct expression for position at time, t.	
M1	Use $t = 4$ and Pythagoras to find the distance OP. Must use an expression that has come from an attempt to **integrate v** **M0 if they find** $\sqrt{\left(-\frac{89}{3}\right)^2+59^2}$	
A1	Correct answer, accept 72 or better 72.2249.., Accept $\dfrac{22\sqrt{97}}{3}$	

Question number	Scheme	Marks
5		
5(a)	Method to find a relevant vertical displacement	M1
	Eg • Single *suvat* equation $0=(25\sin 60°)^2+2(-g)h$ • Conservation of energy: $\frac{1}{2}m(25)^2-\frac{1}{2}m(25\cos 60°)^2=mgh$	A1
	$h=\frac{1875}{8g}$ (23. 9158..)	A1
	Max height = 144 or 140 (m)	A1
		(4)
5(b)	Horizontal component of velocity = $25\cos 60°$	B1
	Method to find vertical component of velocity when t = 5 s $v=25\sin 60°-5g$	M1
	Use of trig to find relevant angle Eg $\tan^{-1}\left(\frac{\text{their } v}{25\cos 60°}\right)$ or inverse	M1
	 65° below the horizontal or 25° to downward vertical. Direction can be implied from diagram	A1
		(4)
5(c)	Complete method to find the required length of time	M1
	$120=(25\sin 60°)t+\frac{1}{2}gt^2$	A1
	3.2 or 3.21 (s)	A1
		(3)
		(11)

	Notes for question	
(a)		
M1	Complete method to find a relevant vertical displacement using *suvat* or conservation of energy. Requires all terms and no extras. Condone sign errors and sin/cos confusion.	
A1	Correct unsimplified equation(s) in relevant vertical displacement only.	
A1	Correct relevant vertical displacement.	
A1	Correct required height, 2/3sf.	
(b)		
B1	Correct horizontal component of speed. May be seen on a diagram.	
M1	Complete method to find the vertical component of speed $t = 5$. Requires all terms and no extras. Condone sign errors and sin/cos confusion.	
M1	Complete method to find the direction of motion when $t = 5$.	
A1	Correct direction. Accept $65°$ or $65.4°$ and below the horizontal oe, accept if clear from a diagram. Accept $65.4°$ to horizontal, $155°$ to vertical etc with diagram A0 for $155°$ or $15.4°$ without diagram A0 for $-65.4°$ or $65.4°$ above horizontal	
(c)		
M1	Complete method to find the required length of time using *suvat*. Requires all terms and no extras. Condone sign errors and sin/cos confusion. Method may use more than one *suvat* equation. Eg Time to B – Time taken to be level with A FYI: Time from A to ground =7.62871 s Time from A to top =2.2092 s Time from A back to same level =2(2.2092) =4.41849s NB Candidates who only look at $\lvert\mathbf{v}\rvert > 25$ will get $t > 4.418$, but for full method need to consider total length of flight (7.62.) and then find difference.	
A1	Correct unsimplified equation(s) in required time only.	
A1	Correct answer and no others, 2/3sf	

Question number	Scheme	Marks
6		
6(a)	Equation for CLM	M1
	$5m(3u) = 5mv + 3mw$ **or** $5m(3u) = -5mv + 3mw$	A1
	Use of impact law	M1
	$3ue = w - v$ **or** $3ue = w + v$	A1
	$\frac{15u}{8}(1+e)$ *	A1*
		(5)
6(b)	Velocity of P after collision, (to the right.) $v = \frac{3u}{8}(5-3e)$	M1
	$(5-3e) > 0 \Rightarrow \frac{3u}{8}(5-3e) > 0$	A1
	Uses $(0 <) e \leqslant 1$ to determine direction of P, compares with direction of Q and concludes correctly*	A1*
NB: Possible max scores for last two A marks in (b) • If $(0 <) e \leqslant 1$ seen followed by both positive, then A1A1 • If $(0 <) e < 1$ seen followed by both positive, then A1A0 • If $e_{\max} = 1$ seen followed by $v = \frac{3}{4}u > 0$, then A1A1 • If $e = 1$ only seen followed by both positive then, A1A0 • If $e = 1$ and $e = 0$ used, then A1A0 • If $e = 1$ and $e = 0$ used **and** $(0 <) e \leqslant 1$ seen, then A1A1 • If v_P and v_Q found then states $v_P > 0$, $v_Q > 0$ with no reference to e values, then A0A0		
		(3)
6(c)	Rebound speed of Q $\frac{15u}{16}(1+e)$	B1
	Use of impulse - momentum	M1
	$\frac{45mu}{4} = 3m\left(\frac{15u}{16}(1+e) - -\frac{15u}{8}(1+e)\right)$	A1ft
	$e = \frac{1}{3}$	A1
		(4)
		(12)

	Notes for question	
(a)		
M1	Equation for CLM. Dimensionally correct, all terms required. Condone sign errors. Mass and velocity paired correctly.	
A1	Correct unsimplified equation, accept $\pm v$	
M1	Use of impact law. Condone sign errors but must be used the right way round.	
A1	Correct unsimplified equation, sign of v consistent with CLM.	
A1*	Obtain given answer from correct working. Must be in factorised fraction form, allow equivalent factorised forms. Must be at least one line of working after equations with preferably an equation in w only	
(b)		
M1	Method to find the velocity of P after the collision.	
A1	Correct deduction without justification. Allow $(3e-5)<0$ followed by $e<\frac{5}{3}$ Use $e = 1$, or 'better' to show that $v_P > 0$	
A1*	Correct justification i.e. uses $(0<)e\leqslant 1$, compares with direction of Q and concludes correctly. Fully correct answer using either $e_{\max}=1$ or $e\leqslant 1$, to show that $v_P > 0$ [and $e > 0$ to show that $v_Q > 0$] A0 If uses (0 <) e < 1	
(c)		
B1	Correct rebound speed of Q after the collision with the wall, in terms of e and u allow $\pm$	
M1	Impulse-momentum equation using result from (a) and rebound speed of Q. May not replace w until later in working eg $\frac{45mu}{4}=3m\left(w--\frac{w}{2}\right)$ w must be substituted for this M mark. Candidates could solve for $w=\frac{5}{2}u$ and then equate this to w $\frac{5}{2}u=\frac{15u}{8}(1+e)$	
A1ft	Correct unsimplified equation in e (m and u). Follow their rebound speed of Q.	
A1	Correct answer. Allow 0.33 or better. Note that calculators can solve the equation so there may be little evidence of working out.	

Question number	Scheme	Marks
7		
7(a)	$F = \mu 2mg\cos\alpha$	M1
	Use of WD to give an equation in μ	M1
	$\dfrac{3mgd}{13} = \mu(2mg\cos\alpha)\times d$	A1
	$\mu = \dfrac{1}{8}$	A1
		(4)
7(b)	At least one correct KE term $\dfrac{1}{2}(2m)V^2 \quad \dfrac{1}{2}(5m)V^2$	B1
	At least one correct GPE term $5mgd \quad 2mgd\sin\alpha$	B1
	Work-energy equation	M1
	$\dfrac{3mgd}{13} = (5m)gd - (2m)gd\sin\alpha - \dfrac{1}{2}(2m)V^2 - \dfrac{1}{2}(5m)V^2$	A1
	$V^2 = \dfrac{8gd}{7}$	A1
		(5)
7(c)	**Method 1:** Work-energy equation for A to move the further distance, d to form an equation in w, d, g (with their V substituted).	M1
	$\left(\dfrac{3mgd}{13} = \dfrac{1}{2}(2m)V^2 - \dfrac{1}{2}(2m)w^2 - (2m)gd\sin\alpha\right)$ $\dfrac{3mgd}{13} = \dfrac{1}{2}(2m)\dfrac{8gd}{7} - \dfrac{1}{2}(2m)w^2 - (2m)gd\sin\alpha$ **SC for these two A marks:** uses work energy from start to end to give: $5mgd = 2\left(\dfrac{3mgd}{13}\right) + (2mg)2d\sin\alpha + \dfrac{1}{2}(2m)w^2 + \dfrac{1}{2}(5m)\dfrac{8gd}{7}$	A1 A1
	$w = \sqrt{\dfrac{gd}{7}}$	A1
		(4)

7(c)	**Method 2:** Use F=ma up the plane to find new acceleration **and** then apply *suvat* for second part of motion to form an equation in *w, d, g* (with their *V* substituted*)*. $-F - 2mg\sin\alpha = 2ma'$ leads to $a' = -\frac{g}{2}$ **And** then apply "$v^2 = u^2 + 2as$ " to get	M1
	$w^2 = V^2 - 2\times\frac{g}{2}\times d \Rightarrow w^2 = \frac{8gd}{7} - 2\times\frac{g}{2}\times d$	A1A1
	$w = \sqrt{\frac{gd}{7}}$	A1
		(13)
	Notes for question	
(a) M1	Use $F = \mu R$ with $R = 2mg\cos\alpha$ Condone sin/cos confusion.	
M1	Use work-done to form an equation in μ . *R* must be in the form $kmg\cos\alpha$ or $kmg\sin\alpha$ Dimensionally correct, all terms required and no extras. Condone sign errors and sin/cos confusion. *d*'s may have been cancelled	
A1	Correct unsimplified equation.	
A1	Correct μ . Accept 0.13, 0.125, $\frac{1}{8}$	
(b) B1	At least one correct KE term	
B1	At least one correct GPE term	
M1	Use work-energy to form an equation for *A* and *B*. Dimensionally correct, all terms required and no extras. Condone sign errors and sin/cos confusion. Correct mass-speed pairings used.	
A1	Correct unsimplified equation	
A1	Correct expression for V^2 Accept 1.1*gd* or better. Answer must be in terms of *g* and *d*	
(c) M1	Complete method to form an equation in *w, d, g* (their *V* must be substituted) **Method 1:** Use work-energy to form an equation for *A* moving a distance *d*. Dimensionally correct, all terms required and no extras. Condone sign errors and sin/cos confusion. Correct mass-speed pairings used **Method 2:** Use N2L for new acceleration **and** *suvat* to find *w* **SC:** Use work-energy to form an equation for *A* moving a distance 2*d*. Dimensionally correct, all terms required and no extras. Condone sign errors and sin/cos confusion. Correct mass-speed pairings used	
A1	Unsimplified equation with at most one error. Allow their *V* (substituted) for this mark. Trig does not need substituting.	
A1	Correct unsimplified equation. Trig does not need substituting. Maybe implied by final answer.	
A1	Correct expression. Accept $0.38\sqrt{gd}$ or better. Answer must be in terms of *g* and *d*	