Mark Scheme (Results)

Summer 2025

Pearson Edexcel International Advanced Level In Mechanics M2 (WME02) 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

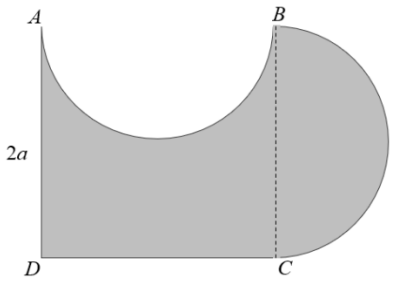
(NB specific mark schemes may sometimes override these general principles)

- 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	N.B. Calculator warning :' Not entirely'	
1(a)	Differentiate displacement to find an expression for velocity.	M1
	$v = 8t^3 - 42t^2 + 45t + 14$	A1
	Substitutes $t = 2$ to find $v = 0$ Or solves $v = 0$ to give $t = -\frac{1}{4}, 2, 3.5$ N.B. Only stating with no working t=2,v=0 or v=0,t=2 is A0	A1*
		(3)
1(b)	Complete method to find total distance = $\lvert x_2 - x_0 \rvert + \lvert x_3 - x_2 \rvert$	M1
	$\frac{95}{2}$ (m)	A1
		(2)
1(c)	Differentiates velocity $24t^2 - 84t + 45$	M1
	Substitute $t =$ 1.5 into differentiated expression	M1
	Correct **magnitude** of acceleration 27 ($\mathrm{m\,s^{-2}}$)	A1
		(3)
		(8)
	Notes for question	
1(a)		
M1	Differentiate given expression with at least two powers of t decreasing by 1.	
A1	Correct differentiated expression.	
A1*	Obtain t=2 from correct and complete working. If solving equation, and if any incorrect roots appear A0.	
1(b)		
M1	Complete method to find the total distance. Do not condone sign errors. (x_0=0 ,x_2=38, x_3=28.5)	
A1	Correct distance, must be positive	
1(c)		
M1	Differentiate velocity to find an expression for acceleration with at least two powers of t decreasing by 1.	
M1	Substitute 1.5 into their differentiated velocity.	
A1	Correct answer, must be positive.	

QUESTION NUMBER	SCHEME	MARKS
2		
2(a)	<table><tr><td></td><td>Mass ratio</td><td>Distance from AD</td></tr><tr><td>Square</td><td>$4a^2$</td><td>a</td></tr><tr><td>Semicircle removed</td><td>$\frac{\pi a^2}{2}$</td><td>a</td></tr><tr><td>Semicircle attached</td><td>$\frac{\pi a^2}{2}$</td><td>$\frac{4a}{3\pi}+2a$</td></tr><tr><td>Lamina</td><td>$4a^2$</td><td>$\bar{x}$</td></tr></table>	B1 (mass) B1 (distances)
	Moments equation about AD or a parallel axis	M1
	About AD $\left(4a^2\times a\right)-\left(\frac{\pi a^2}{2}\times a\right)+\frac{\pi a^2}{2}\left(\frac{4a}{3\pi}+2a\right)=4a^2\bar{x}$ About BC $4a^2(a)-\frac{\pi a^2}{2}(a)-\frac{\pi a^2}{2}\left(\frac{4a}{3\pi}\right)=4a^2(2a-\bar{x})$ About line joining midpoints of AB and DC $4a^2(0)-\frac{\pi a^2}{2}(0)+\frac{\pi a^2}{2}\left(a+\frac{4a}{3\pi}\right)=4a^2(\bar{x}-a)$	A1
	Obtain given answer from correct working. $\bar{x}=\frac{a}{24}(28+3\pi)$ *	A1*
		(5)
2(b)	Relevant moments equation	M1
	$T\times 2a=W\frac{a}{24}(28+3\pi)$	A1
	Second relevant equation	M1
	e.g. $5T=W+kW$	A1
	$k=\left(\frac{92+15\pi}{48}\right)$	A1
		(5)
		(10)
	Notes for question	
2(a)	**Vector form is acceptable for part a**	

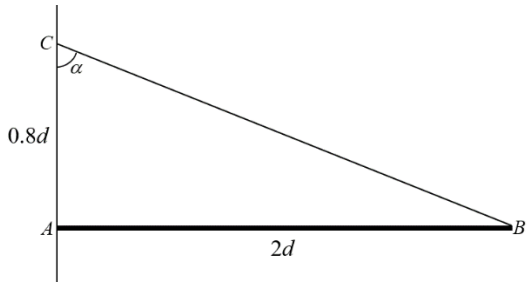
B1	Correct mass ratios for all 4 sections.	
B1	Correct distances for square and two semicircle sections measured from their moments line. (or shape to LHS of BC and semicircle)	
M1	Moments taken about *AD* or a parallel axis. Dimensionally correct equation. All terms required. 'a^2's may have been cancelled. LHS correct and RHS uses their $\bar{x}$.	
A1	Correct unsimplified equation in terms of a, $\bar{x}$ and π.	
A1*	Obtain given answer from correct working. At least one stage of simplification must be seen. Must be factorised with Allow$(28+3\pi)$ and $(3\pi+28)$	
2(b)		
M1	Form a moments equation about *AD* or a parallel axis. Dimensionally correct equation. All terms required.	
A1	Correct unsimplified equation. Allow in terms of $\bar{x}$. Accept decimal form for $\bar{x}$	
M1	Second relevant equation (moments or vertical equilibrium). Dimensionally correct equation. All terms required.	
A1	Correct unsimplified equation. Accept decimal form for $\bar{x}$ Other possible moments equations include: About *B*: $4T\times 2a - kW\times 2a - W\left(2a-\bar{x}\right)=0$ About midpoint *AB*: $4T\times a - kWa - W\left(\bar{x}-a\right) - Ta = 0$ About G: $4T\,\bar{x} - kW\,\bar{x} = T\left(2a-\bar{x}\right)$	
A1	Cao Accept equivalent forms in the form $p + q\pi$, but must be **exact**	

QUESTION NUMBER	SCHEME	MARKS
3	Accept column vectors throughout this question	
3(a)	Complete method to find greatest height (h) e.g. $0 = 14^2 + 2(-g)h$	M1
	$h = 10$	A1
		(2)
3(b)	Vertical component $v = 14 - g(2.4)$	M1
	Use Pythagoras to find Speed = $\sqrt{8^2 + (14 - 2.4g)^2}$	M1
	12.4 or 12 (ms^{-1})	A1
		(3)
3(c)	Relevant equation in t formed using vertical motion. e.g. $3 = 14t + \frac{1}{2}(-g)t^2$	M1 A1
	Use Horizontal motion to find the required distance $8t$	M1
	8x 2.6..	A1
	21 or 21.0 (m)	A1
		(5)
	ALT method forming trajectory equation	
	Relevant equation in t and y formed using vertical motion. $y = 14t - \frac{1}{2}gt^2$	M1
	Form relevant horizontal equation in x and t $x = 8t$	M1
	Eliminate t to form correct equation in x and y $y = 14 \times \frac{x}{8} - \frac{1}{2}g\left(\frac{x}{8}\right)^2$	A1
	Substitute y=3 into correct equation and solve for x	A1
	21 or 21.0 (m)	A1
		(5)
	ALT method using Energy	
	Vertically: $\frac{1}{2}(m)(14^2 - v^2) = 3(m)g$	M1
	Form vertical suvat equation in their v and t $v = 14 - gt$	M1
	$\sqrt{\frac{686}{5}} = 14 - gt$	A1

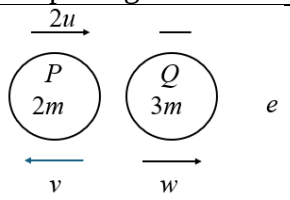
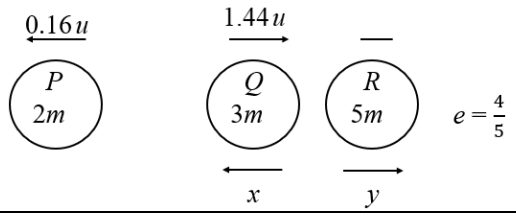
	8x2.6…	A1
	21 or 21.0 (m)	A1
		(5)
		(10)
	Notes for question	
3(a)		
M1	Complete method to find greatest height. Condone sign errors.	
A1	cao	
3(b)		
M1	Complete method to find the vertical component at t=2.4 Condone sign errors.	
M1	Use of Pythagoras with both components to find speed	
A1	Correct answer, 2/3sf	
3(c)		
M1	Relevant equation formed using vertical motion. Condone sign errors.	
A1	Correct unsimplified equation(s). (Note t = 2.62 (3sf) but does not need to be seen for this mark)	
M1	Use horizontal motion to find the required distance	
A1	Uses 'larger' t=2.6...to calculate distance AB	
A1	Correct answer with 2 or 3sf. Accept 21, 21.0.	
	Alt method Trajectory **Enter marks in correct M and A spaces**	
M1	Relevant equation formed in t and y using vertical motion.	
M1	Form relevant horizontal equation in x and t	
A1	Eliminate t to form correct equation in x and y	
A1	Substitute t=3 into correct equation and solve for x	
A1	Correct answer with 2 or 3sf. Accept 21, 21.0.	
	Alt method Energy	
M1	Form (vertical) energy equation,m's may have been cancelled and 8^2 may have been added to both velocity parts	
M1	Form vertical suvat equation in their v and t	
A1	Substitute correct value for v ($\sqrt{\frac{686}{5}}$=11.71..) and solve for t	
A1	Uses t=2.62...to calculate distance AB	
A1	Correct answer with 2 or 3sf. Accept 21, 21.0.	

QUESTION NUMBER	SCHEME	MARKS
4		
4(a)	Equation of motion	M1
	$D-30=70(0.4)$	A1
	Use of $P=D\times 5$	M1
	$P=$ 290 (W)	A1
		(4)
4(b)	At least one correct KE term $\frac{1}{2}\times 70\times 8^2$ $\frac{1}{2}\times 70\times 5^2$	M1
	Work done against resistance = 250×30	B1
	Work-energy equation	M1
	$70gH=\frac{1}{2}\times 70\times 8^2-\frac{1}{2}\times 70\times 5^2+250\times 30$	A1
	H = 13 or 12.9 (m)	A1
		(5)
4(c)	Total work done	M1
	$70g(200\sin 5°)+(30\times 200)$	A1
	18000 (J)	A1
		(3)
		(12)
	Notes for question	
4(a)		
M1	Equation of motion. Dimensionally correct with all required terms and no extras.	
A1	Correct unsimplified equation.	
M1	Use of $P=D\times 5$	
A1	Correct answer, 290 (W)	
4(b)		
M1	At least one KE term correctly formed.	
B1	Expression seen for work done against resistance.	
M1	Work-energy equation. Dimensionally correct with all required terms and no extras or double counting. Mass must be replaced with 70. Condone sign errors.	
A1	Correct unsimplified equation.	
A1	Correct answer, 2/3sf	
4(c)		
M1	Expression for total work done. Dimensionally correct with all required terms and **no extras or double counting.** Mass must be replaced with 70. (the 200 may be used as 8x25)	
A1	Correct unsimplified expression for total work done.	
A1	Correct answer, 2/3sf	
	N.B. Penalise accuracy only once in entire question. **N.B**. Answers only in part a) M0A0M0A0, part b) M0B0M0A0 and in part c) M1A1A1	

QUESTION NUMBER	SCHEME	MARKS
5	Accept column vectors throughout the question.	
	Velocity in component form eg $\mathbf{v}=(v\cos 45°)\mathbf{i}\pm(v\sin 45°)\mathbf{j}$ OR $\mathbf{v}=\lambda\mathbf{i}\pm\lambda\mathbf{j}$	M1 A1
	Change in momentum in vector form $0.5\mathbf{v}-0.5(6\mathbf{i})$	M1 A1
	Use of magnitude of impulse to form an equation **in one unknown**. eg $\frac{3\sqrt{2}}{2}=\sqrt{(0.5v\cos 45°-3)^2+(0.5v\sin 45°)^2}$ OR $\frac{3\sqrt{2}}{2}=\sqrt{(0.5\lambda-3)^2+(0.5\lambda)^2}$	M1 A1
	$-\frac{3}{2}\mathbf{i}+\frac{3}{2}\mathbf{j}$ $-\frac{3}{2}\mathbf{i}-\frac{3}{2}\mathbf{j}$	A1 A1
		(8)
	Notes for question	
	Accept column vectors throughout the question.	
M1	Velocity after impact as components in variable form.	
A1	Correct unsimplified expressions Eg $\mathbf{v}=(v\cos 45)\mathbf{i}\pm(v\sin 45)\mathbf{j}$ or $\mathbf{v}=\lambda\mathbf{i}\pm\lambda\mathbf{j}$	
M1	$m(\mathbf{v}-\mathbf{u})$ used in vector form.	
A1	Correct unsimplified expression, $0.5\mathbf{v}-0.5(6\mathbf{i})$	
M1	Use of magnitude of **impulse** to form an equation in one unknown. Eg $\frac{3\sqrt{2}}{2}=\sqrt{(0.5v\cos 45°-3)^2+(0.5v\sin 45°)^2}$ $(\Rightarrow v=3\sqrt{2})$ Or $\frac{3\sqrt{2}}{2}=\sqrt{(0.5\lambda-3)^2+(0.5\lambda)^2}$ $(\Rightarrow \lambda=3)$	
A1	Correct unsimplified equation.	
A1	At least one correct expression for impulse must be in $p\mathbf{i}+q\mathbf{j}$ form for this mark	
A1	Two correct expressions for impulse. Do not penalise lack of $p\mathbf{i}+q\mathbf{j}$ form twice.	
	N.B. Case1: If solution appears as per scheme, then full marks possible **Case 2**: If no ± in line one but two solutions emerge at end, then full marks available **Case 3**: If only one sign used in line one, and only one solution appears at end, then max M1A0M1A1 M1A1A1A0	

QUESTION NUMBER	SCHEME	MARKS
6		
6(a)	A complete method to find an equation in *T*, *m*, *g*, *k* (and α).	M1
	E.g. Moments about *A* $(T\cos\alpha\times 2d)=(mg\times d)+(kmg\times 2d)$	A1, A1
	$T=\frac{mg\sqrt{29}}{4}(2k+1)$ *	A1*
		(4)
6(b)	Vertical equation	M1
	Correct equation Eg Vertical equilibrium $Y+T\cos\alpha=mg+kmg$	A1
	Horizontal equation	M1
	Correct equation Eg Horizontal equilibrium $X=T\sin\alpha$	A1
	Use of $\tan\theta=\frac{Y}{X}$ to form an equation in *k* only	M1
	$k=\frac{11}{10}$ or 1.1	A1
		(6)
		(10)
	Notes for question	
6(a)		
M1	A complete method to find an equation in *T*, *m*, *g*, *k* and α or size of angle at *B,say* β. Dimensionally correct with all required terms. Condone sign errors and sin/cos confusion. '*g*' missing, count as one accuracy error	
A1	Correct unsimplified equation(s) with at most one error.	
A1	Correct unsimplified equation(s).	
A1*	Complete method to substitute trig and correctly obtain the given answer. At least one line of working between the equation and the given answer. Note: $\cos\alpha=\frac{2}{\sqrt{29}}$, $\sin\alpha=\frac{5}{\sqrt{29}}$, $\tan\alpha=\frac{5}{2}$ $\sin\beta=cos\alpha$, $\cos\beta=\sin\alpha$, $\tan\beta=\frac{2}{5}$ Allow factor as (2*k*+1) or (1+2*k*)	
6(b)		

M1	Resolve vertically. Dimensionally correct with all terms required. Condone sign errors and sin/cos confusion. Must be using correct angle	
A1	Correct unsimplified equation. Allow for Y downwards ie +/-Y	
M1	Resolve horizontally. Dimensionally correct with all terms required. Condone sign errors and sin/cos confusion. Must be using correct angle.	
A1	Correct unsimplified equation.	
M1	Use of $\tan\theta = \frac{Y}{X}$ to form an equation in k only, so +/-1/8 or +/-8 must have been used. Allow for Y downwards ie -Y/X, consistent with first use of their Y	
A1	Correct value for k. Must be **exact**.	
	N.B For X and Y allow use of $R\cos\theta$ and $R\sin\theta$ or N and μN	

QUESTION NUMBER	SCHEME	MARKS
7	N.B. throughout this question refer to diagram for the direction of speeds and then apply to equations. N.B. Correct mass-speed pairings are needed for all M marks	
		
7(a)	CLM	M1
	$2m(2u) = 2m(-v) + 3m(w)$	A1
	Use of impact law	M1
	$e(2u) = w + v$	A1
	$w = \frac{4u}{5}(e+1)$ *	A1*
		(5)
7(b)	Find an expression involving v , e and u	M1
	Correct expression Eg $v = \frac{2u}{5}(3e-2)$	A1
	Use $v > 0$ to form an inequality in e, $\Rightarrow \quad \frac{2}{3} < e \leq 1$	A1
		(3)
7(c)	Use of Impulse-momentum	M1
	$\frac{108mu}{25} = 3m \times \frac{4u}{5}(e+1)$	A1
	$e = \frac{4}{5}$ *	A1*
		(3)
7(d)		
	$v = 0.16u$, 4/25u Allow +/-	B1
	Use of CLM with their v $3m(1.44u) = 3m(-x) + 5m(y)$ $3m\left(\frac{4u}{5}(e+1)\right) = 3m(-x) + 5m(y)$	M1

	Use of impact law with their v $0.8(1.44u) = x + y$ $e\left(\frac{4u}{5}(e+1)\right) = x + y$	M1
	Correct expression $x = 0.18u$ o.e.	A1
	Compare the speed of P after the first collision with the speed of Q after the second collision. ($v = 0.16u$ and $x = 0.18u$)	dM1
	Since $0.18u > 0.16u$ a third collision will occur (between P and Q)	A1
		(6)
		(17)
	Notes for question	
7(a)		
M1	Equation for CLM. Dimensionally correct, all terms required. Condone sign errors.	
A1	Correct unsimplified equation.	
M1	Use of impact law. Condone sign errors but must be used the right way round.	
A1	Correct unsimplified equation, signs consistent with CLM.	
A1*	Obtain given answer from correct working. Must be factorised with $(e+1)$ for this mark. Allow $(1+e)$	
7(b)		
M1	Find an expression involving their v_p after the first collision with u and e only for their direction	
A1	Correct unsimplified expression for v_p after the first collision with u and e for their direction.	
A1	Use the direction of P and their expression for v to form a correct inequality in e, both ends required.	
7(c)		
M1	Use of impulse-momentum equation. Dimensionally correct, condone sign errors.	
A1	Correct unsimplified equation.	
A1*	Obtain given answer from complete and correct working. At least one line of working form equation to answer as a 'Show that'	
7(d)		
B1	Correct expression seen for speed of Q after the first collision. Allow $-0.16u$,$-4/25u$	
M1	Form relevant CLM equation using given answer from (a). Dimensionally correct, all terms required. Condone sign errors. No need for e to be replaced.	
M1	Use of impact law with given answer from (a). Condone sign errors but must be used the right way round. No need for e to be replaced.	

A1	Correct expression from correct working for the speed and direction of Q after the second collision, e must be replaced. Allow +/- answer o.e	
dM1	Compare the speed of P after the first collision with the speed of Q after the second collision ($v = 0.16u$ and $x = 0.18u$) Dependent on two previous M marks. Velocities must have been found in terms of u prior awarding this mark	
A1	Cso. Since $0.18u > 0.16u$ a second collision could occur between P and Q	
	N.B. if all that is seen is '. ($v = 0.16u$ and $x = 0.18u$) and then so second collision'. This is M0A0 as no comparison has occurred.	