Mark Scheme (Results)

October 2025

Pearson Edexcel International Advanced Level in Mechanics M2

WME02/01

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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 $\surd$ symbol 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:
   - 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

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

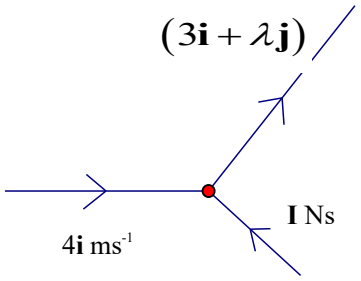
- Rules for M marks:
    - correct number of terms
    - dimensionally correct
    - all terms that need resolving (i.e. *multiplied* by cos or sin) are resolved
    - only terms that need resolving are resolved
    - +/− errors are condoned
    - sin/cos confusion is condoned
- Omission or extra g in 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

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		Mark	Note
	Use the mass to determine which part of the system is being considered.		
1a	Equation of motion for the car and trailer or for each **with** T eliminated	M1	Need all terms. Dimensionally correct. M0 if they use power as a force. Condone sign errors.
	$F-350-200=(500+150)a$	A1	Correct unsimplified equation in F and a
	Use of $(F=)\ \frac{10500}{14}\ (=750)$ seen	M1	Independent M0 for just $14F = 10500$, with no subsequent working.
	$a=\frac{4}{13}$	A1	Accept 0.31 or better. 0.30769……
		[4]	
1b	Equation of motion for the car or the trailer to give an equation in T and a only.	M1	Need all relevant terms. Dimensionally correct. M0 if they use power as a force. Condone sign errors.
	$T-200=150\times\ '\frac{4}{13}'$ or $750-350-T=500\times\ '\frac{4}{13}'$	A1**ft**	Correct unsimplified equation, follow their a.
	$T=\frac{3200}{13}$	A1	Accept 250 or better 246.15338…….
		[3]	
		(7)	

Question Number		Mark	Note
2a			
	Impulse momentum equation	M1	Must be subtracting but condone subtraction in the wrong order Condone poor notation e.g. $\sqrt{29}=2(3\mathbf{i}+\lambda\mathbf{j})-2(4\mathbf{i})\left(=2(-\mathbf{i}+\lambda\mathbf{j})\right)$
	$(\mathbf{I}=)\ 2(3\mathbf{i}+\lambda\mathbf{j})-2(4\mathbf{i})\left(=2(-\mathbf{i}+\lambda\mathbf{j})\right)$	A1	Correct unsimplified expression for **I** Accept $2(\mathbf{i}-\lambda\mathbf{j})$
	Correct use of magnitude for their impulse e.g. $29=4(1+\lambda^2)$	M1	Allow with square roots on both sides
	$\lambda=2.5$	A1	Or equivalent. Must be positive.
		[4]	
2b	Correct use of trig or scalar product to find ratio for a relevant angle, for $4\mathbf{i}$ and their **I** e.g. $\tan\theta=\pm\frac{2}{2\lambda}$ or $\pm\frac{2\lambda}{2}$ or equivalent sin or cos equation.	M1	M0 if they use $(3\mathbf{i}+\lambda\mathbf{j})$ M0 for $\tan^{-1}\frac{2}{5}-\tan^{-1}4$ or similar
	Correct ratio for a relevant angle e.g. $\tan\theta=\pm\frac{2}{5}$ or $\pm\frac{5}{2}$ or equivalent sin or cos equation e.g. $\cos\theta=\frac{-2}{\sqrt{29}}$	A1ft	Follow their λ
	$111.801409...°$ or 1.9513027…. radians	A1	Accept $110°$ or 2, 2.0 radians or better
		[3]	
		(7)	

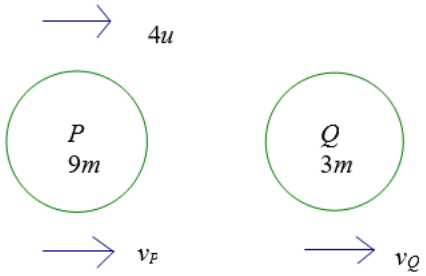
Question Number		Mark	Note
	Accept column vectors throughout apart from in the answer to part (b).		
3a	Use of $\mathbf{a}=\frac{\mathrm{d}\mathbf{v}}{\mathrm{d}t}$ $\left(\mathbf{a}=2\mathbf{i}+(2t-5)\mathbf{j}\right)$	M1	At least two powers of *t* going down by 1.
	$t=4\Rightarrow\mathbf{a}=2\mathbf{i}+3\mathbf{j}\left(\mathrm{m\,s^{-2}}\right)$	A1	Isw if they find the magnitude.
		[2]	
3b	Use $\mathbf{r}=\int\mathbf{v}\,\mathrm{d}t$	M1	At least two powers of *t* going up by 1
	$\mathbf{r}=\left(t^2+3t+A\right)\mathbf{i}+\left(\frac{1}{3}t^3-\frac{5}{2}t^2-15t+B\right)\mathbf{j}$	A1	Allow without constant of integration
	Use of $t=1$, $\mathbf{r}=6\mathbf{i}-2\mathbf{j}$ to **find** the (vector) constant of integration	M1	$\left(1+3+A=6,\quad\frac{1}{3}-\frac{5}{2}-15+B=-2\right)$ Must find *A* and *B*.
	$\left(t^2+3t+2\right)\mathbf{i}+\left(\frac{1}{3}t^3-\frac{5}{2}t^2-15t+\frac{91}{6}\right)\mathbf{j}$	A1	Cao (exact)
		[4]	
3c	Use the velocity and the direction to form an equation in *T*.	M1	Condone if 5 and -3 on the wrong sides of the equation.
	$-3\times(2T+3)=5\times\left(T^2-5T-15\right)$ oe	A1	Correct unsimplified equation in *T* or *t*
	$5T^2-19T-66=0\quad\left((5T+11)(T-6)=0\right)$ $\Rightarrow\quad T=6$	**D**M1	Simplify and solve for *T*, dependent on M1.
	Use of Pythagoras with their *T*: $\left(v=\sqrt{(2\times6+3)^2+\left(6^2-5\times6-15\right)^2}\right)$	M1	Independent but not available if they have more than one positive *T* value.
	$v=\sqrt{306}\left(=3\sqrt{34}\right)\left(\mathrm{m\,s^{-1}}\right)$	A1	Must be exact, accept either. Isw if they go on to give a decimal.
		[5]	
		(11)	

Question Number		Mark	Note
4a	<table><tr><td></td><td>*ABDE*</td><td>*BCD*</td><td>*PQR*</td><td>template</td></tr><tr><td>Mass</td><td>16</td><td>8π</td><td>2π</td><td>$6\pi+16$</td></tr><tr><td>From *BD*</td><td>$-a$</td><td>$\frac{16a}{3\pi}$</td><td>$\frac{8a}{3\pi}$</td><td>(*d*)</td></tr></table>	B1 B1	Correct mass ratios Correct distances from *BD* or from a parallel axis (Condone sign error)
	Moments about *BD*, using their table **N.B**. c of m of 'RH part' = $\frac{112a}{18\pi}$ then $\left(\frac{112a}{18\pi}\times 6\pi\right)-16a=(6\pi+16)d$	M1	Allow use of a parallel axis. Dimensionally consistent terms. All terms required. Correct pairings Condone sign error(s)
	$-16a+8\pi\times\frac{16a}{3\pi}-2\pi\times\frac{8a}{3\pi}=(6\pi+16)d$	A1	Correct unsimplified equation for their parallel axis.
	$d=\frac{64a}{3(16+6\pi)}=\frac{32a}{3(8+3\pi)}$ *	A1*	Obtain **given answer** from full and correct working. Need *d* = not $\bar{x}$
		[5]	
4b	Vertical distance of c of m from *B* = 4*a*	B1	Seen or implied
	Use of trigonometry to obtain a relevant angle $\tan\phi=\frac{32a}{3(8+3\pi)\times 4a}$ e.g. $\left(=\frac{8}{3(8+3\pi)}\right)\ (=0.153....)$	M1	M0 if they don't use 4*a*
	$\phi=8.7$	A1	8.7 or better (8.700966…)
		[3]	
4c	Moments about *B* or any other complete method to obtain in equation in *k*, *W* and *a* only. e.g. resolve horizontally (*X* = *W*) and	M1	All terms required. Terms dimensionally consistent. Condone sign

	vertically ($Y = (15 + k)\,W$) and Moments about another point.		errors.
	$\frac{32}{3(8+3\pi)} a \times 15W - 2akW = 8a \times W$	A1 A1	Unsimplified equation with at most one error Correct unsimplified equation
	$(k) = \frac{48-12\pi}{8+3\pi}$ or equivalent single fraction	A1	0.59 or better (0.59116…..)
		[4]	
		(12)	

Question Number		Mark	Note
5a	Correct use of Pythagoras e.g. $AC = \sqrt{(25a)^2 - (7a)^2} = 24a$ *	B1*	Allow quotation of the Pythagorean triple without detailed working. Need '*AC* =' B0 if error(s) in working e.g. $\sqrt{576a}$
		[1]	
5b	Moments about *A* or equivalent complete method.	M1	Dimensionally consistent. Condone sine/cosine confusion. Allow M1A0A0 if *a*'s never appear. M0 if they use 25*a* instead of 24*a*
	$W \times 15a \times \cos\theta = 24aN$	A1	Correct unsimplified equation
	$N = \frac{15}{25}W = \frac{3}{5}W$ *	A1*	Obtain **given answer** from correct working. Must see use of $(\cos\theta =)\frac{24}{25}$
		[3]	
5c	Resolve vertically:	M1	First equation (enter first on ePEN). Condone sine/cosine confusion. Condone sign error.
	$R_A + N\cos\theta = W \left(R_A = \frac{53}{125}W \right)$	A1	Correct unsimplified equation
	Resolve horizontally:	M1	Second equation (enter second on ePEN). Condone sine/cosine confusion. Condone sign error.
	$F_A = N\sin\theta \left(= \frac{21}{125}W \right)$	A1	Correct unsimplified equation
	Alternatives for either of the above equations: Resolve perpendicular to the rod: $N + R_A\cos\theta = W\cos\theta + F_A\sin\theta$ Resolve parallel to the rod: $W\sin\theta = F_A\cos\theta + R_A\sin\theta$ M(C): $9a \times W\cos\theta + 24a \times F_A\sin\theta = 24a \times R_A\cos\theta$		

	M(*B*): $6aN+30a\times R_A\cos\theta=30a\times F_A\sin\theta+15a\times W\cos\theta$ M(*G*): $15a\times F_A\sin\theta+9aN=15a\times R_A\cos\theta$		
	Use $F_A=\mu R_A$ to obtain an equation in μ only.	**D**M1	Substitute their values correctly, dependent on both M's, to obtain an equation in μ only. This mark is only available if they use the equations for which they have been awarded marks.
	$\mu=\frac{21}{53}$ or an equivalent fraction	A1	Accept 0.4, 0.40 or better (0.39622….)
		[6]	
		(10)	

Question Number		Mark	Note
6a			
	Use of CLM	M1	Need all terms. Dimensionally consistent Must be using the correct masses.
	$9m\times 4u = 9mv_P + 3mv_Q$	A1	Correct unsimplified equation
	Impact Law	M1	Used the correct way round $\left(v_{\text{sep}} = e\times v_{\text{app}}\right)$
	$v_Q - v_P = 4ue$	A1	Correct unsimplified equation
	Obtain $\left(v_Q\right) = 3u\left(1+e\right)$ *	A1*	Obtain given answer correctly with at least one line of intermediate working.
		[5]	
6b	$v_P = u\left(3-e\right)\left(=\frac{7}{3}u\right)$ or negative of these	B1	Seen or implied
	KE lost $=\frac{1}{2}.9m.\left(4u\right)^2 - \frac{1}{2}.9m.\left(v_P\right)^2 - \frac{1}{2}.3m.\left(v_Q\right)^2$	M1	Correct form for KE. Need all terms. Condone subtraction the wrong way round i.e. all signs reversed.
	$=\frac{1}{2}.9m.\left(4u\right)^2 - \frac{1}{2}.9m.\left(\frac{7u}{3}\right)^2 - \frac{1}{2}.3m.\left(5u\right)^2$ $(=72mu^2 - 24.5mu^2 - 37.5mu^2)$ $(=18mu^2(1-e^2))$	A1ft	Correct unsimplified expression in *m* and *u* only Follow their v_P
	$(k=)10$	A1	cao
		[4]	

6c	$w = 5uf$ or $-5uf$	B1	Or equivalent. Seen or implied Condone a sign error here.
	$21mu = 3m \times 5u - 3m \times w$ $(w = -2u)$	M1	Impulse momentum equation. Dimensionally correct. Must be using 3*m*. Condone sign error and in terms of e.
	$(f =) \frac{2}{5}$ oe	A1**cso**	
		[3]	
		(12)	

Question Number		Mark	Note
7a	$F_{\max} = \frac{1}{3} \times 0.5g \times \frac{12}{13}$	M1	Use of $F = \mu R$. Allow $\cos\alpha$ Condone sine/cosine confusion
	Work done $= F_{\max} \times 5$	DM1	For their $F_{\max}$ Dependent on previous M1
	Work done = 7.5 (J)	A1	7.5(J) or 7.54 (J) or $\frac{10g}{13}$ Not $\frac{98}{13}$ (follows substitution for g).
		[3]	
7b	Work-energy equation	M1	Need all terms. Condone sign errors and sine/cosine confusion.
	$\frac{1}{4}U^2 = \frac{1}{4}.26^2 + \frac{1}{2}g.5\sin\alpha + their\ \text{WD}$	A1ft A1ft	Unsimplified equation with at most one error Correct unsimplified equation
	(U =) 27	A1	27 or 27.3 (2 sf or 3 sf)
		[4]	
7c	Use of $v = u + at$	M1	Complete method using *suvat*
	$-26\sin\alpha = 26\sin\alpha - gT \quad (20 = gT)$ **OR** $0 = 26\sin\alpha \times T - \frac{1}{2}gT^2$ **OR** $T = 2 \times \frac{26\sin\alpha}{g}$	A1	Correct unsimplified equation in T or t.
	(T =) 2.0	A1	2, 2.0 or 2.04 (2sf or 3sf)
		[3]	
7d	Use of $s = ut + \frac{1}{2}gt^2$	M1	Complete method for time to ground using *suvat*
	$-5\sin\alpha = 26\sin\alpha t - \frac{1}{2}gt^2$	A1	Unsimplified equation with at most one error

	$(t = 2.2177...)$	A1	Correct unsimplified equation
	ALT 1: time up + time down	M1	Complete method using *suvat*
	$\frac{26\sin\alpha}{g} + \frac{2}{g}\sqrt{\left(\frac{(26\sin\alpha)^2}{2g} + 5\sin\alpha\right)}$ =(1.0204 + 1.1973)	A1 A1	Unsimplified equation with at most one error Correct unsimplified equation
	Horizontal distance, $X = 26\cos\alpha \times t$ (53.22)	**D**M1	Use of $u\cos\alpha t$ or equivalent, dependent on M1.
	Total distance $= 5\cos\alpha + 26\cos\alpha \times t$	M1	Use of: their $X + 5\cos\alpha$
	$= 58\ (\text{m})$	A1	58 or 57.8 (2sf or 3sf)
		[6]	
		(16)	