Pearson

Mark Scheme (Results)

January 2026

International Advanced Level in Mechanics M3

WME03/01

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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
   - $\sqsubset$ 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.

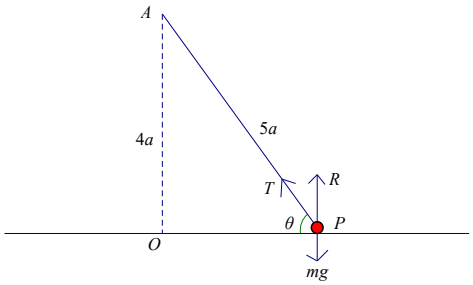
General Principles for Mechanics Marking

(***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

Question Number	Scheme	Marks	Notes
1a	Find first and second derivatives of x wrt t	M1	Must see both derivatives with $\cos \to \sin \to \cos$ Condone sign errors
	$\dot{x} = -0.6k \sin\left(kt + \frac{\pi}{4}\right)$, $\ddot{x} = -0.6k^2 \cos\left(kt + \frac{\pi}{4}\right)$	A1	Both derivatives correct.
	$\ddot{x} = -k^2 x$ *	A1*	Obtain **given answer** from full and correct working
		(3)	
1b	Amplitude = 0.6 (m)	B1	Correct only
		(1)	
1c	Max speed $0.6k \left(\text{m s}^{-1}\right)$	B1	Correct only
		(1)	
1d	$4 = \frac{2\pi}{\omega} \left(= \frac{2\pi}{k}\right)$	M1	Use of $T = \frac{2\pi}{\omega}$
	$k = \frac{\pi}{2}$	A1	cao
		(2)	
1e	$\pm\frac{1}{3} = \cos\left(\frac{1}{2}\pi t + \frac{\pi}{4}\right)$	M1	Solve for a relevant value of t Allow with their k.
	$t_1 = 0.2837..$	A1	One correct time
	$t_2 = 0.7163..$, $T = t_2 - t_1$	M1	Complete method to obtain the required time
	Time A to B = 0.43 (s)	A1	0.43 or better
		(4)	
		[11]	

Question Number	Scheme	Marks	Notes
2a			
	Resolve vertically	M1	Need all terms. Dimensionally correct. Condone sign error and sine / cosine confusion
	$R+T\sin\theta=mg$ $\left(R+\frac{4}{5}T=mg\right)$	A1	Correct unsimplified equation
	Equation for circular motion	M1	Dimensionally correct. Condone sign error and sine / cosine confusion
	$T\cos\theta=m\times 3a\omega^2$ $\left(\frac{3}{5}T=m\times 3a\omega^2\right)$	A1	Correct unsimplified equation
	Substitute $\omega=\frac{1}{4}\sqrt{\frac{g}{a}}$ and obtain R	M1	As far as an equation in R, m and g
	$R=\frac{3mg}{4}$	A1	Or exact equivalent
		(6)	
2b	Use $mg-T\sin\theta>0$ to obtain ω	M1	
	$\omega<\frac{1}{2}\sqrt{\frac{g}{a}}$ *	A1*	**Given answer** from correct working
		(2)	
		[8]	

Question Number	Scheme	Marks	Notes
3a	Use $\frac{dv}{dt}=\frac{dv}{dx}\times\frac{dx}{dt}$	M1	Use of chain rule or $\frac{d}{dx}\left(\frac{1}{2}v^2\right)$
	Correct method for $\frac{dv}{dx}$	M1	Correct quotient rule or equivalent (allow one slip)
	Correct derivative	A1	e.g. $\frac{8x}{3+x^2}\times\frac{8\left(3+x^2\right)-16x^2}{\left(3+x^2\right)^2}$
	Substitute $x=3$ into their derivative	DM1	Dependent on the first M1
	Obtain $\frac{2}{3}\left(\text{m s}^{-2}\right)$	A1	Must be positive. Accept 0.67 or better
		(5)	
3b	$\frac{dx}{dt}=\frac{8x}{3+x^2}$	M1	Use of $v=\frac{dx}{dt}$
	$\int\frac{3+x^2}{8x}dx=\int 1dt \quad \left(=\int\frac{3}{8x}+\frac{x}{8}dx\right)$	M1	Separate and attempt integration (as far as 2 terms of the correct form)
	$\frac{3}{8}\ln x+\frac{1}{16}x^2=t\left(+C\right)$	A1	Correct integration. Allow if "+ C" not seen
	Use $x=1$ when $t=2$ to obtain C	M1	In an expression containing at least 2 of $p\ln x, qx^2, rt$
	$t=\frac{5}{2}+\frac{3}{8}\ln 3$	A1	Or exact equivalent
		(5)	
		[10]	

Question Number	Scheme	Marks	Notes
4a	<table><tr><td></td><td>H-sphere</td><td>Cylinder</td><td>Cone</td><td>S</td></tr><tr><td>Mass</td><td>$18\pi a^3$</td><td>$81\pi a^3$</td><td>$18\pi a^3$</td><td>$81\pi a^3$</td></tr><tr><td>To O</td><td>$9a+\frac{9a}{8}$</td><td>$\frac{9a}{2}$</td><td>$\frac{3a}{2}$</td><td>d</td></tr></table>	B1 B1	
	Moments about a horizontal axis through O	M1	Or a parallel axis. Dimensionally consistent. Need all terms. Condone sign errors.
	$18\times\frac{81a}{8}+81\times\frac{9a}{2}-18\times\frac{3a}{2}=81d$	A1	Correct unsimplified equation for their axis.
	$\frac{2079}{4}a=81d\Rightarrow d=\frac{77a}{12}$ *	A1*	Obtain given answer from correct working
		(5)	
4b	Moments about toppling point, or equivalent complete method	M1	Dimensionally consistent. Using $9a$ and $3a$
	$9aH=3aW\Rightarrow H=\frac{1}{3}W$	A1	
		(2)	
		[7]	
5	Moments about B	M1	Dimensionally correct. Condone sine / cosine confusion
	$Mg\times\frac{3l}{2}\sin 2\theta=T\cos\theta\times 3l$	A1 A1	Unsimplified equation in T or *their* T with at most one error. Correct unsimplified equation in T or *their* T
	$T=\frac{5Mgx}{8\times 2l}$	M1	Correct use of Hooke's Law seen or implied.
	$Mg\times\frac{3l}{2}\times 2\sin\theta\cos\theta=\frac{5Mgx}{16l}\cos\theta\times 3l$ $\left(\sin\theta=\frac{5x}{16l}\right)$	M1	Substitute for T and use double angle formula to obtain equation in x, l and θ
	$(\sin\theta=)\frac{l+\frac{1}{2}x}{3l}=\frac{5x}{16l}$	M1	Use trig to form an equation in x and l
	$\Rightarrow 16l+8x=15x\Rightarrow x=\frac{16l}{7}$ *	A1*	Obtain given answer from correct working.
		(7)	
		[7]	

Question Number	Scheme	Marks	Notes
6a	Moments about the y-axis	M1	Use of $\int xy\mathrm{d}x$. Limits not needed. Powers going up by 1
	$\int_{-2}^{4}\frac{1}{4}x^3+2x\,\mathrm{d}x=\left[\frac{1}{16}x^4+x^2\right]_{-2}^{4}$	A1	Correct integration and correct limits seen
	$\bar{x}=\frac{\left[\frac{1}{16}x^4+x^2\right]_{-2}^{4}}{18}$	M1	Use of $\bar{x}=\frac{\int xy\,\mathrm{d}x}{18}$
	$=\frac{27}{18}=\frac{3}{2}$ *	A1*	Obtain given answer from correct working
		(4)	
6b	Moments about the x axis	M1	$\int\frac{1}{2}y^2\mathrm{d}x=\frac{1}{2}\int\frac{x^4}{16}+x^2+4\,\mathrm{d}x$ Correct squaring. Powers going up by 1. Condone if the half is missing.
	$\frac{1}{2}\left[\frac{x^5}{80}+\frac{x^3}{3}+4x\right]_{-2}^{4}$	A1	Correct integration and correct limits seen or implied
	$\bar{y}=\frac{\frac{1}{2}\left[\frac{x^5}{80}+\frac{x^3}{3}+4x\right]_{-2}^{4}}{18}$	M1	Use of $\bar{y}=\frac{\frac{1}{2}\int y^2\,\mathrm{d}x}{18}$
	$\bar{y}=\frac{153}{5\times18}=\frac{17}{10}$ *	A1*	Obtain given answer from correct working
		(4)	
6c	Correct use of trig to find tangent of a relevant angle	M1	e.g. $\tan\theta=\frac{4-\frac{3}{2}}{6-\frac{17}{10}}$
	$\tan\theta=\frac{25}{43}$	A1	
		(2)	
		[10]	

Question Number	Scheme	Marks	Notes
7a	EPE at $B = \dfrac{18Mg\times(2a)^2}{5\times 6a}$	M1	Correct form for EPE seen or implied. Allow if correct formula stated but slip in substitution.
	Work-energy equation	M1	Need all terms. Dimensionally correct. Condone sign errors
	$Mg\times 2a+\dfrac{1}{2}Mv^2=\dfrac{18Mg\times(2a)^2}{5\times 6a}$	A1	Correct unsimplified equation
	$v=\sqrt{\dfrac{4ag}{5}}$	A1	Accept exact equivalent or $0.89\sqrt{ag}$ or better
		(4)	
7b	Work-energy equation	M1	Need all terms. Dimensionally correct. Condone sign errors.
	$\dfrac{18Mg\times 4a^2}{5\times 6a}=Mg(2a+x)+\dfrac{18Mg\times x^2}{5\times 6a}$ or $\dfrac{1}{2}M\times their\dfrac{4ag}{5}=Mgx+\dfrac{18Mg\times x^2}{5\times 6a}$ $(3x^2+5ax-2a^2=0)$	A1 A1	Unsimplified equation in one unknown length with at most one error Correct unsimplified equation in one unknown length
	$x=\dfrac{a}{3}\Rightarrow$ distance from $A=\dfrac{8a}{3}$	A1	$2.7a$ or better
		(4)	
		[8]	

Question Number	Scheme	Marks	Notes
8a	Conservation of energy from A to general position	M1	Need all terms. Dimensionally correct. Condone sign errors and sine / cosine confusion
	$\frac{1}{2}m\times 4ag + mg\times 4a\cos\theta = \frac{1}{2}mv^2$	A1	Correct unsimplified equation
	Equation for circular motion	M1	Need all terms. Dimensionally correct. Condone sign errors and sine / cosine confusion
	$T - mg\cos\theta = \frac{mv^2}{4a}$	A1	Correct unsimplified equation
	Eliminate v^2 and solve for T	DM1	Dependent on both preceding M marks
	$\frac{mv^2}{4a} = T - mg\cos\theta = mg + 2mg\cos\theta$ $\Rightarrow T = mg(1+3\cos\theta)$ *	A1*	Obtain given answer from correct working.
		(6)	
8b	Substitute $\theta = 0$ in the energy equation	M1	Or equivalent method to obtain the speed
	$4amg + 8amg = mv^2 \Rightarrow v = \sqrt{12ag}$	A1	$3.5\sqrt{ag}$ or better
		(2)	
8c	Conservation of energy from A to C	M1	Or equivalent. Need all terms. Dimensionally correct. Condone sign errors
	$\frac{1}{2}m\times 4ag + mg\times 2a = \frac{1}{2}mw^2$	A1	Correct unsimplified equation
	$w = \sqrt{8ag}$	A1	Or exact equivalent
		(3)	
8d	Speed of $P = 2\sqrt{ag}$	B1	Seen or implied
	Equation of motion: $T + mg = \frac{mv^2}{2a}\left(= \frac{m\times 4ag}{2a}\right)$	M1	Need all terms, with *their* v substituted. Condone sign errors.
	$T = mg$	A1	cso
		(3)	
		[14]	