PMT

Mark Scheme (Results)

October 2020

Pearson Edexcel IAL In Mechanics 1
Paper WME01/01

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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.

- 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)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- $*$ The answer is printed on the paper
- ⌐ 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.

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

(But note that specific mark schemes may sometimes override these general principles)

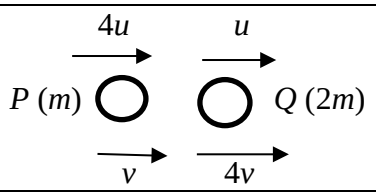
- Rules for M marks: correct no. of terms; dimensionally correct; all terms that need resolving (i.e. multiplied by cos or sin) are resolved.
- Omission or extra g in a resolution is an accuracy error not method error.
- Omission of mass from a resolution is a method error.
- Omission of a length from 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.

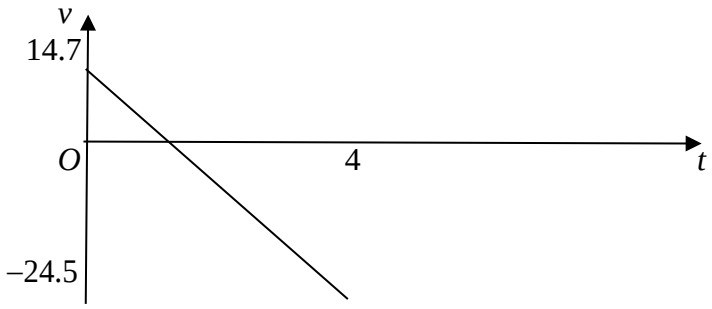
  N.B. Over-accuracy or under-accuracy of correct answers should only be penalised *once* per complete question. However, premature approximation should be penalised every time it occurs.

  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, LHS	Right hand side, left hand side

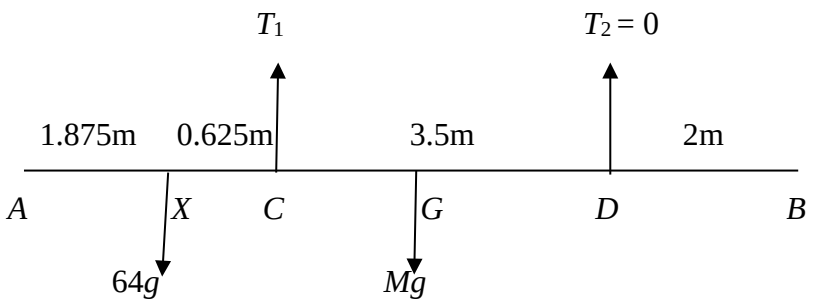
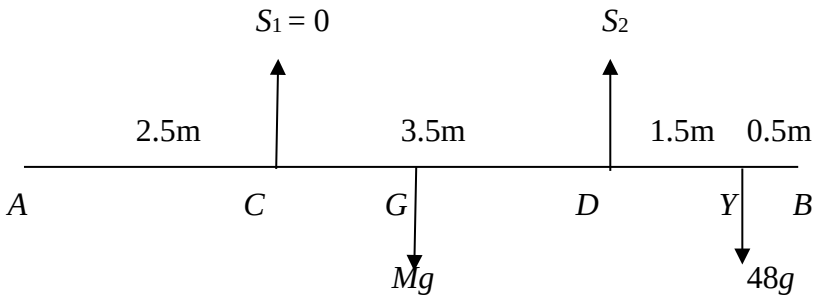
UPDATE 6

Question Number	Scheme	Marks
1(a)		
	CLM: $4mu + 2mu = mv + 2m \times 4v$	M1 A1
	$4v = \frac{8u}{3}$ (2.7u or better)	A1
		(3)
(b)	$\pm m(v-4u)$ **OR** $\pm 2m(4v-u)$	M1 A1**ft**
	$\frac{10mu}{3}$ (3.3mu or better)	A1
		(3)
(c)	Opposite to the direction of motion	B1
		(1)
		(7)
	Notes for Question 1	
1(a)	M1 Correct number of terms, dimensionally correct, condone sign errors Allow even if they assume that both are moving with the same speed after the collision.	
	A1 Correct equation, allow cancelled m's or consistent extra g's	
	A1 Correct answer (must be positive as it's a speed) and a single term.	
1(b)	M1 Dimensionally correct imp-momentum equation (M0 if g is included), with correct terms, condone sign errors, but must be a difference of momenta and must be using EITHER m and $4u$ and their v_P OR $2m$ and u and their v_Q	
	A1**ft** Correct expression, in terms of m and u, follow their v_P or v_Q A0ft if they assume that both move with the same speed after the collision	
	A1 cao Must be positive as it's a magnitude	
1(c)	B1 Any clear equivalent	

Question Number	Scheme	Marks
2(a)	Complete method to find the total time: e.g. $-19.6 = 14.7t + \frac{1}{2}(-9.8)t^2$ using one equation **OR:** $0 = 14.7 - 9.8t_1 \Rightarrow t_1 = 1.5$ $s_1 = 14.7 \times 1.5 - \frac{1}{2} \times 9.8 \times 1.5^2 = 11.025$ using four equations $30.625 = \frac{1}{2} \times 9.8 \times t_2^{\ 2} \Rightarrow t_2 = 2.5$ $t = t_1 + t_2 = 4$ (s) and many other methods	M1
	There are two A marks for all the equations they use, -1 each error	A1
		M(A)1
	$t = 4$ (s) only	A1
		(4)
(b)	$v^2 = 14.7^2 + 2(-9.8)(-19.6)$ **OR** $v = 14.7 + (-9.8) \times 4$	M1 A1
	Speed = 24.5 or 25 (m s^{-1})	A1
		(3)
(c)	e.g $0^2 = 14.7^2 + 2(-9.8)s$ or $24.5^2 = 2 \times 9.8s$	M1
	$s = 11.025$ (11 or better) $s = 30.625$	A1
	Total distance = $2 \times 11.025 + 19.6$ Total distance = 2 x 30.625 – 19.6	M1
	= 41.7 (3 sf) or 42 (2 sf) (m)	A1
		(4)
(d)		B1 line B1 start pt (0,14.7) **OR** on axes B1**ft** end pt (4,-24.5) **OR** on axes
		(3)
		(14)

	Notes for Question 2	
2(a)	M1 **Complete** method to find the total time	
	A1 M(A)1 There are now two A marks for the equation(s) that they use, -1 for each error.	
	A1 Correct answer **N.B**. If using a quadratic, ignore the other solution, even if it's incorrect. If they combine the 2 solutions in some way, A0	
2(b)	M1 Complete method to find the speed	
	A1 Correct equation(s)	
	A1 Correct answer must be positive	
2(c)	M1 Method to find a relevant distance	
	A1 A correct relevant distance	
	M1 Method to find the total distance	
	A1 Correct answer	
2(d)	B1 Straight line starting on the v-axis and crossing the t-axis (line may be reflected in the t-axis) (B0 if solid vertical line at $t = 4$)	
	B1 Correct appropriate coordinates (start point) Allow these to be marked on the axes.	
	B1**ft** Correct appropriate coordinates (end point) ft on their answers to (a) and (b) Allow these to be marked on the axes.	

Question Number	Scheme	Marks
3(a)	$R = 10g\cos\alpha$	M1
	= 78.4 or 78 (N)	A1
		(2)
(b)	$F = 0.5R$	B1
	$P = 10g\sin\alpha + F$	M1A1
	= 98	A1
		(4)
(c)	$P = 10g\sin\alpha - F$	M1
	= 19.6 or 20	A1
		(2)
		(8)
	Notes for Question 3	
3(a)	M1 Allow sin/cos confusion	
	A1 Correct answer. Allow 8*g*.	
3(b)	B1 $F = 0.5R$ seen anywhere	
	M1 Correct number of terms, with 10*g* resolved	
	A1 Correct equation or inequality	
	A1 Correct answer. Allow 10*g*.	
	For any inequality which never becomes an equation, usual rules: Max M1A1A0 for $P \leq 10g\sin\alpha + F$	
3(c)	M1 Correct number of terms, with 10*g* resolved	
	A1 Correct answer. Allow 2*g*	
	For any inequality which never becomes an equation, usual rules: Max M1A0	

Question Number	Scheme	Marks
4.		
	Use of $T_2 = 0$	M1
	$M(C), 64g \times 0.625 = Mg(d - 2.5)$ **OR e.g.** $M(C), 64g \times 0.625 = Mgx$	M1 A1
	Other equations: (T_1 would then have to be eliminated to give an equation in M and d only, to earn the M mark) $T_1 = Mg + 64g$ $M(A), 64g \times 1.875 + Mgd = 2.5T_1$ $M(G), 64g \times (d - 1.875) = T_1 \times (d - 2.5)$ $M(D), 64g \times 4.125 + Mg(6 - d) = 3.5T_1$ $M(B), 64g \times 6.125 + Mg(8 - d) = 5.5T_1$ $M(X), Mg(d - 1.875) = 0.625T_1$	
		
	Use of $S_1 = 0$	M1
	$M(D), 48g \times 1.5 = Mg(6 - d)$ **OR e.g.** $M(D), 48g \times 1.5 = Mg(3.5 - x)$	M1 A1
	Other equations: (S_2 would then have to be eliminated to give an equation in M and d only, to earn the M mark) $S_2 = Mg + 48g$ $M(A), 48g \times 7.5 + Mgd = 6S_2$ $M(C), 48g \times 5 + Mg(d - 2.5) = 3.5S_2$ $M(G), 48g \times (7.5 - d) = S_2 \times (6 - d)$ $M(B), 48g \times 0.5 + Mg(8 - d) = 2S_2$ $M(Y), Mg(7.5 - d) = 1.5S_2$	
	Solve for M	**DM**1
	$M = 32$ exact answer.	A1
		(8)
		(8)

	Notes for Question 4	
	M1 $T_2 = 0$ seen or implied	
	M1 Correct number of terms, dimensionally correct equation <u>in M and one unknown length</u>. (allow without *g*'s, omission of a length is an M error)	
	A1 Correct equation in *M* and *d only* or another unknown length.	
	M1 $S_1 = 0$ seen or implied	
	M1 Correct number of terms, dimensionally correct equation <u>in M and same unknown length</u>. (allow without *g*'s, omission of a length is an M error)	
	A1 Correct equation in *M* and *d only* or same unknown length.	
	DM1 Solving for *M*, dependent on all previous M marks	
	A1 Correct exact answer	

Question Number	Scheme	Marks
5(a)	Put $t = 2$ to give $-3\mathbf{i} + 4\mathbf{j}$	M1
	$\sqrt{(-3)^2 + 4^2}$ The – sign is not required	M1
	5 (m s^{-1})	A1
		(3)
(b)	e.g. $\tan\theta = \frac{3}{4}$	M1
	A correct equation	A1**ft**
	37° or 323° nearest degree	A1
		(3)
(c)	$\mathbf{v} = (7 - 5t)\mathbf{i} + (12t - 20)\mathbf{j}$	
	$= (7\mathbf{i} - 20\mathbf{j}) + t(-5\mathbf{i} + 12\mathbf{j})$	M1
	$\frac{\mathbf{v} - (7\mathbf{i} - 20\mathbf{j})}{t} = (-5\mathbf{i} + 12\mathbf{j})$	M1 A1
	OR: $t = 0$, $\mathbf{v} = 7\mathbf{i} - 20\mathbf{j}$	M1
	$\frac{(-3\mathbf{i} + 4\mathbf{j}) - (7\mathbf{i} - 20\mathbf{j})}{2} = (-5\mathbf{i} + 12\mathbf{j})$	M1A1
	OR: Differentiate wrt t	M2
	$\frac{d\mathbf{v}}{dt} = \mathbf{a} = (-5\mathbf{i} + 12\mathbf{j})$	A1
		(3)
(d)	$\frac{(7 - 5t)}{(12t - 20)} = \frac{-5}{8}$	M1 A1
	Solve for t	M1
	$t = 2.2$	A1
		(4)
		(13)

	Notes for Question 5	
5(a)	M1 Allow column vectors	
	M1 Finding the magnitude of their **v**	
	A1 Correct answer	
5(b)	M1 For a relevant trig equation	
	A1**ft** A correct equation follow through on their **v**	
	A1 Correct answer (must be in degrees to nearest degree)	
5(c)	M1 Collecting terms in t and constant terms (may be implied)	
	M1 Rearranging to required form	
	A1 Correct answer (isw if they find the magnitude)	
OR:	M1 Finding the initial velocity or some other specific velocity	
	M1 Use of $\mathbf{a} = \frac{\mathbf{v} - \mathbf{u}}{t}$ with $t = 2$ (or possibly another appropriate value)	
	A1 Correct answer (isw if they find the magnitude)	
5(d)	M1 Attempt at equation in t only, using ratio of components, allow reciprocal and a sign error	
	A1 Correct equation	

	M1 Solve for t (equation must have come from considering ratios)	
	A1 Correct answer	

Question Number	Scheme	Marks
6(a)	$2000-500-500g\sin\alpha=500a$ (truck)	M1 A2
	a = 0.256 or 0.26 (m s^{-2}) (32/125 is A0)	A1
		(4)
(b)	$D-1200-500-1500g\sin\alpha-500g\sin\alpha=2000a$ (system)	M1 A2
	OR: $D-1200-1500g\sin\alpha-2000=1500a$ (engine)	
	D = 7700	A1
	N.B. They may write down the system and engine equations and then: (a) solve them for a (b) solve them for D.	
		(4)
		(8)
	Notes for Question 6	
6(a)	M1 Using equation(s) of motion to give <u>an equation in a only</u>, with correct number of terms and 500g resolved, condone sign errors	
	A1 Equation with at most one error	
	A1 Correct equation	
	A1 Correct answer	
6(b)	M1 Using an equation of motion to give an equation in D and a only, with correct number of terms and 500g (or 1500g) resolved, condone sign errors	
	A1 Equation with at most one error (a does not need to be substituted) Treat omission of g as one error	
	A1 Correct equation	
	A1 Correct answer	

Question Number	Scheme	Marks
7(a)	$5mg - T = 5ma$ **OR** $5mg - T = -5ma$	M1 A1
	$T - 3mg = 3ma$ $\quad\quad$ $T - 3mg = -3ma$	M1 A1
	Solve for T	DM1
	$T = \frac{15mg}{4}$ oe (allow unsimplified and not in terms of mg at this stage)	A1
	Force on pulley = $2T$	M1
	$\frac{15mg}{2}$ oe (must be a single positive term)	A1
		(8)
(b)	The tension is the same on both sides of the pulley.	B1
	Tension is same across the pulley	(1)
		(9)
	Notes for Question 7	
7.(a)	M1 Correct number of terms, condone sign errors (M0 if m's missing)	
	A1 Correct equation	
	M1 Correct number of terms, condone sign errors (M0 if m's missing)	
	A1 Correct equation	
	DM1 Solve for T, dependent on previous two M marks, and must be in terms of m.	
	A1 Correct expression for T	
	M1 Correct method	
	A1 Correct answer	
(b)	B1 Any equivalent statement. B0 if any incorrect extras B0 if pulley not mentioned.	

Question Number	Scheme			Marks
8(a)	$s = \frac{1}{2} \times 3 \times 4^2$	**OR**	$s = \frac{1}{2} \times 4 \times 12$	M1
	= 24 (m)			A1
				(2)
(b)	12 (m s^{-1}); 42 (m s^{-1})			B1
	$12 \times 20 + \frac{1}{2} \times 1.5 \times 20^2$ (= 540)	**OR**	$\left(\frac{12+42}{2}\right) \times 20$	M1 A1ft
	$42 \times 2 + \frac{1}{2}(-4) \times 2^2$ (= 76)	**OR**	$\left(\frac{42+34}{2}\right) \times 2$	M1 A1**ft**
	Total = 640 (m)			A1 cao
				(6)
				(8)
	Notes for Question 8			
8(a)	M1 Complete method to find distance travelled in first 4 s Must be area of a triangle from a *v-t* graph			
	A1 Correct answer			
8(b)	B1 Both speeds seen anywhere e.g. on a diagram or in part (a)			
	M1 Complete method to find total distance travelled in next 20 s Must be area of a trapezium from a *v-t* graph (they may use a rectangle + triangle)			
	A1 **ft** Correct unsimplified distance, **ft** on their 12			
	M1 Complete method to find total distance travelled in next 2 s Must be area of a trapezium from a *v-t* graph (they may use a rectangle + triangle)			
	A1 **ft** Correct unsimplified distance, **ft** on their 42			
	A1 cao for total distance			

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