Pearson Edexcel

Mark Scheme (Results)

October 2021

Pearson Edexcel International A Level
In Mechanics M1 (WME01) 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.

- bod – benefit of doubt
- ft – follow through
- the 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)
- 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.

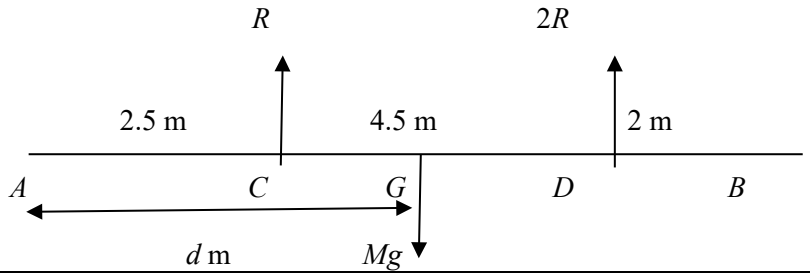
- In all cases, if the candidate clearly labels their working under a particular part of a question i.e. (a) or (b) or (c),……then that working can only score marks for that part of the question.

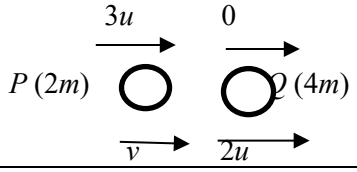
- Accept column vectors in all cases.

- 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.

Question Number	Scheme	Marks
1.		
	1st Equation in d (or another defined unknown), R and M (as appropriate) only	M1 A1
	2nd Equation in d (or the same defined unknown, R and M (as appropriate) only	M1 A1
	Possible equations: $(\uparrow), R+2R=Mg$ $\mathrm{M}(C), 2R\times 4.5=Mg(d-2.5)$ $\mathrm{M}(D), R\times 4.5=Mg(7-d)$ $\mathrm{M}(A), 2.5R+(7\times 2R)=Mgd$ $\mathrm{M}(B), 6.5R+(2\times 2R)=Mg(9-d)$ **SC**: $\mathrm{M}(G), R(d-2.5)=2R(7-d)$	M2 A2,1,0
	Solve for d, must be a numerical value	DM1
	$d = 5.5$	A1 (6)
		(6)
	Notes for question 1	
	N.B. Allow M marks for equations if they use R_c and R_D	
	M1 Correct number of terms, dimensionally correct, condone sign errors and missing g	
	A1 Correct equation	
	M1 Correct number of terms, dimensionally correct, condone sign errors and missing g	
	A1 Correct equation	
	DM1 Dependent on previous two M marks, for solving for d	
	A1 $d = 5.5$ oe Ignore an extra m (but not M)	
	N.B. If g is omitted consistently in both equations, all three A marks are available. If they use Rg consistently in both equations, all three A marks are available. If they have 3 equations, mark the ones that are used to obtain d. If R and $2R$ are consistently the wrong way round, apply the scheme, unless an MR gives a better total.	

Question Number	Scheme	Marks
2.		
2(a)	$2m\times 3u = 2mv + 4m\times 2u$ **OR** $I = 4m\times 2u$ and $-I = 2m(v-3u)$ **AND** add to eliminate I	M1A1
	$v = -u$ so speed is u	A1
		(3)
2(b)	Opposite to its original direction, reversed, in opposite direction, direction QP, opposite direction to Q Direction changed is B0	DB1
		(1)
2(c)	$R = 4mg$	B1
	$F = 4ma$; **OR** $-Ft = 4m\,(0 - 2u)$ $4mg\mu = 4ma$ (their calculated a or unknown a) $-\mu 4mgt = 4m(0-2u)$	M1 A1
	$0^2 = (2u)^2 - 2a\left(\frac{6u^2}{g}\right)$ (their calculated a or an unknown a) **OR** $\frac{6u^2}{g} = \frac{(0+2u)}{2}t$ (their calculated t or an unknown t)	M1A1
	$\mu = \frac{1}{3}$ correctly obtained	A1
		(6)
		(10)
	Notes for question 2	
2(a)	M1 Complete method to give equation in m, u and v only, dimensionally correct, correct no. of terms, condone sign errors and consistent cancelled m's or extra g's	
	A1 Correct equation	
	A1 u ; must be positive	
2(b)	DB1 **Dependent** on an answer of $+u$ or $-u$ in (a)	
2(c)	B1 cao Seen anywhere, e.g. on a diagram	
	M1 Equation of motion (Allow F for friction at this stage) **OR** Impulse-momentum equation	
	A1 Correct equation with F substituted	
	M1 Use of *suvat* to obtain an equation in u and a only **OR** Use of impulse-momentum to obtain an equation in u and t only	
	A1 Correct equation ; equations must be consistent to earn both A marks.	
	A1 Accept 0.33 or better	

Question Number	Scheme	Marks
3(a)	$v^2 = 25^2 - 2\times 6\times 48$	M1
	$v = 7\ (\text{m s}^{-1})$	A1
		(2)
3(b)	$\frac{25-13}{6}$ (2)	M1
	$13^2 = 25^2 - 2\times 6s$ **OR** $25\times 2 - \frac{1}{2}\times 6\times 2^2$ **OR** $\frac{(25+13)}{2}\times 2$ **OR** $13\times 2 - \frac{1}{2}\times(-6)\times 2^2$ ($(s =)$ 38)	M1
	Total time = $\frac{(48-38)}{13} + 2$	DM1
	$\frac{36}{13} = 2\frac{10}{13}$ (s) (2.76923…)	A1
		(4)
3(c)	$\frac{25-13}{6}$ (2) (could be implied by 2.2)	M1
	$(0.2\times 25) + (25\times 2 - \frac{1}{2}\times 6\times 2^2)$ (5 + 38)	M1
	Total time = $\frac{48-[(0.2\times 25)+38]}{13} + 0.2 + 2$	DM1
	$\frac{168}{65} = 2\frac{38}{65}$ (s) (2.58461538..)	A1
		(4)
		(10)
	Notes for question 3	
3(a)	M1 Complete method to find v (condone sign errors)	
	A1 cao	
3(b)	M1 Complete method to find time to reach 13 m s^{-1}	
	M1 Complete method to find distance travelled in reaching 13 m s^{-1} ft on their 2 if necessary	
	DM1 Dependent on previous two M marks, Complete method to find the total time, ft on their 2 and 38	
	A1 Correct answer. Allow 2.8 or better	
3(c)	M1 Complete method to find the time taken to reach 13 m s^{-1} once it starts decelerating	
	M1 Complete method to find total distance travelled in reaching 13 m s^{-1} ft on their 2 if necessary	
	DM1 Dependent on previous two M marks, Complete method to find the total time, ft on their 2 and 38	
	A1 Correct answer. Allow 2.6 or better	

Question Number	Scheme	Marks
	Allow column vectors throughout	
4(a)	$\mathbf{r} = -\mathbf{i} - 3\mathbf{j}$	B1
	$\tan\theta = \pm\frac{1}{3}$ or $\pm\frac{3}{1}$	M1
	162^{O} or 198^{O} nearest degree	A1
		(3)
4(b)	$\sqrt{(t-3)^2 + (1-2t)^2} = 2.5$	M1
	$4t^2 - 8t + 3 = 0 \quad (5t^2 - 10t + 3.75 = 0)$	DM1A1
	$t = \frac{1}{2}$ or $\frac{3}{2}$ isw	M (A)1 A1
		(5)
		(8)
	Notes for question 4	
4(a)	B1 cao	
	M1 for any trig ratio of a relevant angle from <u>their</u> **r** (trig ratio could be implied by a relevant angle) (cosine could come from use of the scalar product of their **r** with **j**)	
	A1 cao	
4(b)	M1 oe	
	DM1, dependent on first M1, for simplifying to a 3 term quadratic or to a form from use of completing the square.	
	A1 correct quadratic	
	M(A)1 for $t = 0.5$	
	A1 for $t = 1.5$	

Question Number	Scheme	Marks
5(a)	$(\uparrow)\ \pm F = 0.2g - 2.5\cos\alpha$ Allow use of (μR) for F	M1 A1
	F = 0.46 (N) oe including fractions , upwards	A1
		(3)
5(b)	$(\uparrow) F + 0.2g = 6.125\cos\alpha$	M1A1
	$(\rightarrow)\ R = 6.125\sin\alpha$ (4.9)	M1A1
	$F = \mu R$	B1
	Solve for μ	DM1
	μ = 0.35 oe including fractions.	A1
	N.B. If F and R are interchanged in their equations, max B1 can be scored.	(7)
		(10)
	Notes for question 5	
5(a)	M1 Correct no. of terms, condone sin/cos confusion and sign errors, allow if they have T instead of 2.5	
	A1 Correct equation . Allow + F or $-F$	
	A1 Need both magnitude (must be positive) and direction	
5(b)	M1 Correct terms, condone sin/cos confusion and sign errors errors allow if they have T instead of 6.125 (but M0 if using T = 2.5)	
	A1 Correct equation	
	M1 Correct terms, condone sin/cos confusion and sign error allow if they have T instead of 6.125 (but M0 if using T = 2.5)	
	A1 Correct equation	
	B1 $F = \mu R$ seen but B0 if they use a value for R found in (a)	
	DM1 Dependent on both M's	
	A1 cao	

Question Number	Scheme	Marks
6(a)	$0 = u - 9.8 \times 2.5$ oe using gradient of graph. Allow g or 9.81 instead of 9.8	M1
	$u = 24.5$ or 25 (m s^{-1}) Allow $2.5g$	A1
	Many other methods	(2)
6(b)	$s = 24.5 \times 2 + \frac{1}{2} \times 9.8 \times 2^2$ **OR** $s = 24.5 \times 7 - \frac{1}{2} \times 9.8 \times 7^2$ **OR** $s = \frac{1}{2} \times 9.8 \times 4.5^2 - (24.5 \times 2.5 + \frac{1}{2} \times (-9.8) \times 2.5^2)$ **OR** $s = \frac{1}{2} \times 9.8 \times 4.5^2 - \frac{1}{2} \times 9.8 \times 2.5^2$ Many other methods, using *suvat* and/or the graph (e.g. similar triangles and area under graph) Allow g or 9.81 instead of 9.8 in all equations.	M1A1**ft**
	68.6 or 69 (m)	A1
		(3)
		(5)
	Notes for question 6	
	For use of $g = 9.81$, which will only affect the final A mark in each part, penalise once for whole question	
6(a)	M1 for complete method using *suvat* or the graph to produce an equation in u only, with correct number of terms, condone sign errors.	
	A1 cao (must be positive)	
6(b)	M1 Complete method to give a final displacement, condone sign errors within a *suvat* equation.	
	A1**ft** Correct equation ft on their u	
	A1 cao	

Question Number	Scheme	Marks
7(a) (i)	$T - 2mg\sin\alpha - F = 2ma$	M1A1
(ii)	$3mg - T = 3ma$	M1A1
	N.B. Ignore the labelling (i) and (ii)	(4)
7(b)	$R = 2mg\cos\alpha$ Allow if this appears in (a).	M1A1
	$F = \frac{1}{2}R$	B1
	Substitute for trig. and solve for a,	DM1
	$a = \frac{1}{5}g$	A1
		(5)
7(c)	$T = \frac{12mg}{5}$ $(23.52m)$	DM1
	$2T\cos\left(\frac{90^o - \alpha}{2}\right)$ **OR** $\sqrt{T^2 + T^2 - 2T^2\cos(90^o + \alpha)}$ **OR** $\sqrt{(T\cos\alpha)^2 + (T + T\sin\alpha)^2}$	M1
	Substitute for trig and T to obtain an expression in m or mg	DM1
	$\frac{48\sqrt{5}mg}{25}$; Accept $4.3mg$ or better, $42m$ or $42.1m$	A1
		(4)
7(d)	Tension is the same on **either side of the pulley**, tension across the pulley is the same.	B1
	B0 for tension is same for A and B or is the same for both strings etc	(1)
		(14)
	Notes for question 7	
	N.B. If m's are consistently missing, mark (a) and (b) as a MR	
7(a)	M1 Correct no. of terms, condone sin/cos confusion and sign errors	
	A1 Correct equation	
	M1 Correct no. of terms, condone sign errors	
	A1 Correct equation **N.B**. Could have a replaced by $(-a)$ in both	
7(b)	M1 Correct no. of terms, condone sin/cos confusion and sign errors	
	A1 Correct equation	
	B1 Seen, possibly on a diagram or in (a)	
	DM1, dependent on the two M's in (a), for solving 2 simultaneous equations or using a whole system equation to find a	
	A1 cao	
7(c)	DM1, dependent on the relevant 1st or 2nd M1 in (a), for attempt to find their T, must be of form km or kmg . Apply isw if they 'cancel' m's.	
	M1 for a **correct** expression in terms of T and α only; α does not need to be substituted	
	DM1, dependent on previous M, for substituting in their T **and** for trig, to give an expression of form km or kmg	
	A1 cao	
7(d)	B1 for any equivalent statement. B0 for incorrect extras.	

Question Number	Scheme	Marks
	Allow column vectors throughout.	
8(a)	$(4\mathbf{i}+6\mathbf{j})=(-2\mathbf{i}+9\mathbf{j})+0.6\mathbf{v}$ oe	M1
	$(10\mathbf{i}-5\mathbf{j})$ (km h^{-1}) * **N.B.** 1 more line of intermediate working needed and must state the answer in **i - j** form to earn this mark.	A1*
		(2)
8(b)	$\mathbf{r}=(-2\mathbf{i}+9\mathbf{j})+t(10\mathbf{i}-5\mathbf{j})$ (km) oe	M1 A1
		(2)
8(c)	t = 1.8: $\mathbf{r}=(-2\mathbf{i}+9\mathbf{j})+1.8(10\mathbf{i}-5\mathbf{j})$	M1
	$\mathbf{r}=16\mathbf{i}$	A1
	t = 2: $\mathbf{r}=(-2\mathbf{i}+9\mathbf{j})+2(10\mathbf{i}-5\mathbf{j})$ **OR** $\mathbf{r}=16\mathbf{i}+0.2(10\mathbf{i}-5\mathbf{j})$	M1
	$\mathbf{r}_L=19\mathbf{i}$ (km)	A1
		(4)
8(d)	$-2+10t=19$	M1
	$t=2.1$	A1
	$\mathbf{r}=(-2\mathbf{i}+9\mathbf{j})+2.1(10\mathbf{i}-5\mathbf{j})$	DM1
	$\mathbf{r}=(19\mathbf{i}-1.5\mathbf{j})$ (km)	A1
		(4)
		(12)
	Notes for question 8	
8(a)	M1 Correct structure with t = 0.6	
	A1* **Given answer correctly obtained**	
	Allow verification.	
8(b)	M1 Correct structure	
	A1 cao	
8(c)	M1 Correct unsimplified substitution of t = 1.8 into their **r** **OR** use t = 1.2 with $(4\mathbf{i}+6\mathbf{j})$ as start point	
	A1 cao	
	M1 Correct unsimplified substitution of t = 2 into their **r** **OR** use t = 1.4 with $(4\mathbf{i}+6\mathbf{j})$ as start point **OR** use t = 0.2 and their first answer as start point	
	A1 cao	
8(d)	M1 Equating **i** component of their **r** to **i** component of their $\mathbf{r}_L$	
	A1 cao	
	DM1 Dependent on previous M1, for substituting their value of t into their **r**	
	A1 cao	

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