Mark Scheme (Results)

Summer 2019

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.

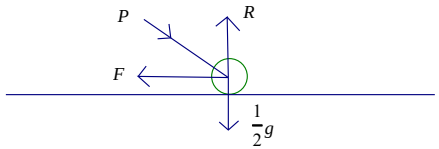
- Accept column vectors in all cases.

- 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.

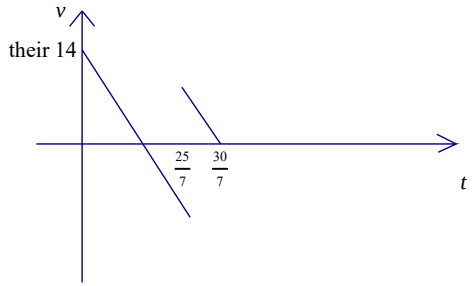
Question Number	Scheme	Marks	Notes
1(a)	Use of CLM	M1	All four terms and dimensionally correct.
	$6mu-8mu=-3mu+2mv$	A1	Correct unsimplified
	$v=\frac{1}{2}u$	A1	Must be positive
		(3)	
(b)	$I=3m(u--2u)$ or $I=2m(\frac{1}{2}u--4u)$	M1	Impulse momentum equation for either particle. Accept +/- Correct process seen or implied. Dimensionally correct. Must link correct masses with the respective speeds
	$I=9mu$	A1	Must be positive
		(2)	
		(5)	

Question Number	Scheme	Marks	Notes
2.			Condone if P acting in the wrong direction but see SC below
	$F = \frac{1}{4}R$	B1	Use of $F = \mu R$ with $\mu = \frac{1}{4}$ seen or implied
	$P\cos 40 = F$	B1	Resolve horizontally. Accept $F\cos 40° = F_{max}$. Not $F\cos 40° = F$
	Resolve vertically	M1	All terms required, and dimensionally correct. $P \neq R$ Condone sign errors and sin/cos confusion
	$P\sin 40 + 0.5g = R$	A1	Correct unsimplified equation
	$P(4\cos 40 - \sin 40) = 0.5g$	DM1	Substitute for R and solve for P. Requires zero acceleration. Dependent on previous M1
	$P = 2.0$ (N) or 2.02 (N)	A1	2 or 3 sf only
		(6)	SC if F opposes their P, 6/6 available If P and F inconsistent max score available B1B0 M1A1follow their diagram DM1A0

Question Number	Scheme	Marks	Notes
3(a)	moments equation	M1	All terms required. Dimensionally correct Condone sign errors
	$M(C),\ Mg\times1.5+100g\times3.5=637\times7$ M(*A*): $2Mg+400g=\frac{1}{2}T+7.5\times637$ M(*P*): $1.5T+100g\times2=637\times5.5$	A1	Correct unsimplified equation
	Resolve vertically or a second moments equation	M1	All terms required. Dimensionally correct Condone sign errors
	$(\uparrow),\quad T+637=Mg+100g$	A1ft	Correct unsimplified equation in *M* or their *M*, *T* or their *T*
	(i) $M=70$	A1	$69.99...=70$ is A0 (from 9.81)
	(ii) $T=1000$N or 1030 N	A1	Not 1029, not $105g$
			They need to form two independent equations. M1A1 for first equation seen M1A1ft for the second equation (ft on any result from the first eqn) A1 for *M*, A1 for *T*.
		(6)	
(b)	Assumed that the beam remains straight	B1	Not flexible B1,Does not bend B1, Extra irrelevant (e.g. centre of mass at midpoint) B0
		(1)	
(c)	$T+T=60g+100g+48g$	M1	Resolve vertically. Need all terms. Equal *T*s. Condone sign errors
	($T=104g$ or 1019.2N)	A1	Correct unsimplified equation
	Moments equation	M1	All terms required. Dimensionally correct. Not using *T* from (a) Condone sign errors
	$M(C),\ 60g\times1.5+100g\times3.5+48g\times(x-0.5)=T\times7$ M(*A*): $60g\times2+100g\times4+48gx=0.5T+7.5T$ M(*B*): $0.5T+7.5T=48g(8-x)+4\times100g+6\times60g$ M(*D*): $100g\times3.5+48g(7.5-x)+60g\times5.5-7T=0$	A1	Correct unsimplified equation
	Solve for *x*	DM1	Solve for our *x*. Dependent on both preceding M marks
	$x=6.5$ (m)	A1	
	Watch out for "correct" answer from working that ignores the $100g$	(6) **(13)**	As above, M1A1 for two independent equations, then DM1A1 for solving

Question Number	Scheme	Marks	Notes
4(i)	Equation of motion for the system	M1	All terms required. Dimensionally correct. Condone sign errors and sin/cos confusion
	$3050-300-2500g\sin\theta=2500a$	A1 A1	Unsimplified equation with at most one error. Correct unsimplified equation NB A sign error on the 300 or a sign error on $2500g\sin\theta$ counts as 2 errors (to be consistent with the penalty if they did this in 2 separate equations).
	$a=0.4$ (m s^{-2})	A1	Not $\frac{2}{5}$ (follows 9.8)
		(4)	
(ii)	Equation of motion for the truck	M1	All terms required. Dimensionally correct. Condone sign errors and sin/cos confusion
	$T-100-500g\sin\theta=500a$ $T=650$ (N)	A1 A1	Unsimplified equation with at most one error. Condone negative T Consistent sign for T. Correct unsimplified equation (in a or their a)
	$T=650$ (N)	A1	Must be positive
		(4)	
(ii) alt	Equation of motion for the engine	M1	All terms required. Dimensionally correct. Condone sign errors and sin/cos confusion
	$3050-200-2000g\sin\theta-T=2000a$ $T=650$ (N)	A1 A1	Unsimplified equation with at most one error. Condone negative T Correct unsimplified equation
	$T=650$ (N)	A1	Must be positive
		(4)	
			(i) and (ii) can be solved together by forming the two separate equations of motion and solving using simultaneous equations. M1A1A1 **for each equation** and A1A1 as above.
			If the 100 N and the 200 N are associated with the wrong vehicles, treat this as a MR. This error gives them $T = 750$
		(8)	

Question Number	Scheme	Marks	Notes
5(a)	$\tan\theta = \frac{2}{3}$	M1	Use trig to find a relevant angle $(56.3°,\ \ 33.7°)$
	Angle is $\theta + 90^{\circ} = 123.69°..$	A1	$124°$ or better (2.16 radians)
		(2)	
(b)	$\mathbf{F}_1 + \mathbf{F}_2 = (a\mathbf{i} + 3\mathbf{j}) + (-4\mathbf{i} + b\mathbf{j})\ (= k(3\mathbf{i} - 2\mathbf{j}))$	M1	Resultant force seen or implied: must be the sum, NOT the difference As a column vector or in **i** / **j** form
	Use direction to form equation in *a* and *b*	M1	From ratio of scalars or 2 separate equations involving $k \neq 1$
	$\frac{a-4}{3+b} = \frac{3}{-2}$	A1	Correct unsimplified equation
	$0 = 2a + 3b + 1$ Given answer	A1	Obtain **given answer** from correct working- need to see evidence
		(4)	
		(6)	

Question Number	Scheme	Marks	Notes
6(a)	$s = ut + \frac{1}{2}at^2$	M1	Complete method using *suvat* to **form** equation in U only
	$-12\frac{1}{2} = \frac{25}{7}U - 4.9(\frac{25}{7})^2$	A1	Correct unsimplified equation Allow $12\frac{1}{2} = \frac{25}{7}U + 4.9(\frac{25}{7})^2$ even if it is not clear that they know why it is true
	$U = 14$	A1	Must be positive
		(3)	
(b)	$s = vt - \frac{1}{2}at^2$	M1	Complete method using *suvat* to **form** equation in s only
	$s = 0 - \frac{1}{2}(-9.8)(\frac{5}{7})^2$	A1	Correct unsimplified equation
	$= 2\frac{1}{2}$ (m)	A1	
		(3)	
(b) alt	$0 = u - g(\frac{5}{7})$ $u = 7$ $s = ut + \frac{1}{2}at^2$	M1	Complete method using *suvat* to **form** equation in s
	$s = 7(\frac{5}{7}) - \frac{1}{2}9.8(\frac{5}{7})^2$	A1	Correct unsimplified equation
	$= 2\frac{1}{2}$ (m)	A1	
		(3)	
(c).		B1	1st line (existing for both +ve and –ve v) ignore figures
		B1	2nd line correct and stopping on the t axis. no other lines. Ignore figures. Parallel to upward portion of their first line if seen.
		B1 ft	Figs. In the right places. Allow U for their 14
		(3)	
			Accept mirror image in the t axis
		(9)	

Question Number	Scheme	Marks	Notes
7(a)	Use of $\mathbf{r} = \mathbf{r}_0 + \mathbf{v}t$	M1	At least once. Must be adding, not subtracting
	$\mathbf{r}_A = (8\mathbf{i} + 7\mathbf{j}) + t(2\mathbf{i} - 14\mathbf{j})$	A1	$\mathbf{r}_A$ correct $\begin{pmatrix} 8+2t \\ 7-14t \end{pmatrix}$
	$\mathbf{r}_B = (\mathbf{i} + 2\mathbf{j}) + t(12\mathbf{i} - 4\mathbf{j})$	A1	$\mathbf{r}_B$ correct $\begin{pmatrix} 1+12t \\ 2-4t \end{pmatrix}$
	$\overrightarrow{BA} = (8\mathbf{i} + 7\mathbf{j}) + t(2\mathbf{i} - 14\mathbf{j}) - \left[(\mathbf{i} + 2\mathbf{j}) + t(12\mathbf{i} - 4\mathbf{j})\right]$	M1	Need to see an indication of method as leading to a given answer
	$= (7 - 10t)\mathbf{i} + (5 - 10t)\mathbf{j}$	A1	Obtain **given answer** from correct working
		(5)	
(b)	Use of Pythagoras to equate distance to 2 km	M1	
	$(7 - 10t)^2 + (5 - 10t)^2 = 2^2$	A1	Correct unsimplified equation in t
	$20t^2 - 24t + 7 = 0$	M1	Form 3 term quadratic in t
	$(10t - 7)(2t - 1) = 0$	DM1	Solve for t. Dependent on the preceding M1. Must see working if using an incorrect quadratic
	$t = \frac{7}{10}$ or $\frac{1}{2}$	A1	
	Time $= \frac{7}{10} - \frac{1}{2}$	DM1	Correct method to find the time interval. Dependent on the preceding M1
	$= \frac{2}{10}$ h (12 min)	A1	
		(7)	
		(12)	

Question Number	Scheme	Marks	Notes
8(a)	Equation of motion for P or for Q&R.	M1	All terms required and dimensionally correct. Condone sign errors. If m missing throughout, mark as a misread
	$5mg - T = 5ma$ or $T - 4mg = 4ma$	A1	One correct unsimplified equation
	Second equation of motion.	M1	Condone if second equation is for the **whole system**
	$5mg - T = 5ma$ $T - 4mg = 4ma$	A1	A second correct unsimplified equation
	Solve for a and T	DM1	Dependent on the first M mark
	$a = \frac{g}{9}$	A1	1.09 or 1.1 not $\frac{49}{45}$
	$T = \frac{40mg}{9}$	A1	43.6m, 44m
		(7)	SC A whole system alone leading to correct a scores M0A0M1A1M0A1A0
(b)	All particles have acceleration of the same magnitude	B1 (1)	Particles all start to move at the same time B1 Extra irrelevant comments B0
(c)	$v^2 = \frac{2gd}{9}$	M1	Complete method to find v or v^2 at the instant of separation
	Two independent equations of motion	M1	Dimensionally correct and contain correct terms
	$3mg - T' = 3ma'$ $T' - 4mg = 4ma'$	A1 A1	A1 for each correct equation. Accept the combined eqn. for A2
	$a' = -\frac{g}{7}$	A1	Accept +/-
	Use of *suvat* to find distance	DM1	With $a \neq$ their $\frac{g}{9}$ or g Dependent on the two preceding M marks
	$0 = \frac{2gd}{9} - 2\frac{g}{7}s$	A1ft	Correct unsimplified equation. Follow their $a \neq$ their $\frac{g}{9}$
	$s = \frac{7d}{9}$	A1	0.78d, 0.778d or better. Must be positive. Do not ISW
		(8)	
		(16)	