Mark Scheme (Results)

Summer 2018

Pearson Edexcel International A Level
in Mechanics M1 (WME01/01)
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.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

PEARSON 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
These are marks given for a correct method or an attempt at a correct method. In Mechanics they are usually awarded for the application of some mechanical principle to produce an equation.
e.g. resolving in a particular direction, taking moments about a point, applying a suvat equation, applying the conservation of momentum principle etc.
The following criteria are usually applied to the equation.

To earn the M mark, the equation
(i) should have the correct number of terms
(ii) be dimensionally correct i.e. all the terms need to be dimensionally correct
e.g. in a moments equation, every term must be a 'force x distance' term or 'mass x distance', if we allow them to cancel 'g' s.
For a resolution, all terms that need to be resolved (multiplied by sin or cos) must be resolved to earn the M mark.

M marks are sometimes dependent (DM) on previous M marks having been earned.
e.g. when two simultaneous equations have been set up by, for example, resolving in two directions and there is then an M mark for solving the equations to find a particular quantity – this M mark is often dependent on the two previous M marks having been earned.

'A' marks
These are dependent accuracy (or sometimes answer) marks and can only be awarded if the previous M mark has been earned. E.g. M0 A1 is impossible.

'B' marks
These are independent accuracy marks where there is no method (e.g. often given for a comment or for a graph)

A few of the A and B marks may be f.t. – follow through – marks.

3. General 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. 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.

6. 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.
- 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)

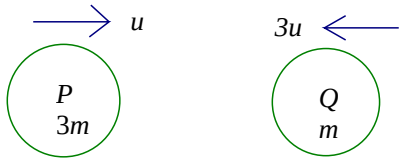
  HL Hooke's Law

  SHM Simple harmonic motion

  PCLM Principle of conservation of linear momentum

  RHS, LHS Right hand side, left hand side.

Mechanics 1 - WME01 June 2018
Mark Scheme

Question Number	Scheme	Marks	Notes
			Mark parts (i) and (ii) together For marking:1st equation in one unknown M1A1 2nd equation in one unknown M1A1 1st value A1, 2nd value A1
1i.	Impulse - momentum equation for P	M1	Must be trying to subtract. Terms dimensionally consistent.
	$5mu = 3m(v_P - -u)$	A1	Correct unsimplified equation
	$v_P = \frac{2u}{3}$	A1	Final answer positive Condone unexplained sign change
1ii.	Impulse momentum equation for Q	M1	Must be trying to subtract Terms dimensionally consistent.
	$5mu = m(v_Q - -3u)$	A1	Correct unsimplified equation
	$v_Q = 2u$	A1	
1ii alt	Use of CLM	M1	Need all terms and dimensionally consistent. Condone sign errors.
	$3mu - 3mu = -3m\frac{2u}{3} + mv_Q$ or $3mu - 3mu = 3mv_P + 2mu$	A1	Correct unsimplified equation
	$v_Q = 2u$	A1	Final answer positive Condone unexplained sign change
		[6]	

Question Number	Scheme	Marks	Notes
	Mark parts (i) and (ii) together		For marking:1st equation M1A1 2nd equation M1A1 1st value A1, 2nd value A1
2a i	Moments equation	M1	Use moments to form an equation in R_C and/or R_D All terms required. Dimensionally correct. Condone sign errors.
	$M(D)$: $(60g \text{ x } 0.6) + (20g \text{ x } 1.6) = R_C \text{ x } 2$ $M(C)$: $(60g \text{ x } 1.4) + (20g \text{ x } 0.4) = R_D \text{ x } 2$ $M(A)$: $2\times 20g + 3\times 60g = 1.6R_C + 3.6R_D$ $M(B)$: $0.4R_D + 2.4R_C = 60g\times 1 + 20g\times 2$	A1	Correct unsimplified equation
	$R_C = 34g$	A1	333 (333.2) is an accuracy error
ii	Resolve vertically	M1	Or form a moments equation in R_D
	$(\uparrow)\ R_C + R_D = 80g$	A1	Correct unsimplified equation
	$R_D = 46g$	A1	451 (450.8) is an accuracy error (penalise once only if g substituted in both answers and correct versions not seen)
		(6)	
2b	Set $R_D = 0$ and use moments to form equation in a relevant distance (One unknown only)	M1	Complete method for a relevant distance Dimensionally correct equation. Using their answers from (a) is M0
	$M(C)$, $(20g\times 0.4) = (60g\times x)$ where x = distance from C when beam tilts	A1	Correct unsimplified equation for a relevant distance
	$\left(x = \frac{2}{15}\right)$		
	Use their distance to find the distance walked	DM1	Dependent on the previous M1
	Distance $= 1.4 + \frac{2}{15} = \frac{23}{15} = 1.53$ m	A1	
		(4)	
		[10]	

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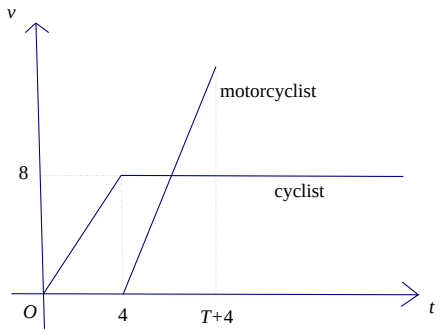
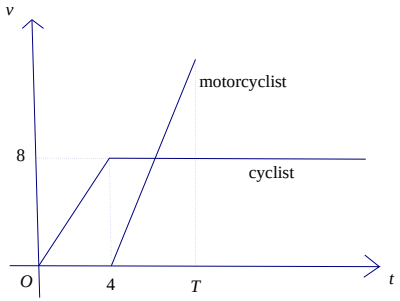
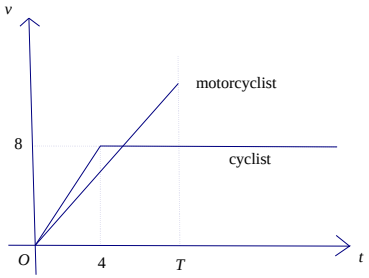
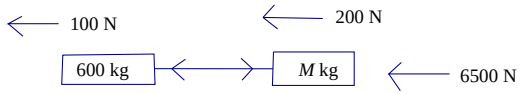
Question Number	Scheme	Marks	Notes
3a		B1 shape B1 figs B1 shape B1 figs (4)	Correct shape graph for cyclist 4 marked Motorcyclist graph in relatively correct position Must start at $t = 4$ and must continue beyond point of intersection of the graphs $T + 4$ marked Treat two separate graphs as two attempts and award the marks for the better attempt
3b	$\frac{1}{2}T.4T = \left(\frac{T+T+4}{2}\right)8$	M1	Equate distances to form equation in T
		A1	One distance correct
		A1	Both distances correct
	$T^2 - 4T - 8 = 0$	A1	Simplify to 3 term quadratic
	$T = 2 \pm \sqrt{12}$	M1	Solve a 3 term quadratic for T
	$T = 5.5$	A1	Q asks for answer to 1 dp. Must reject negative solution if seen.
		(6)	
		[10]	
			See over

Question Number	Scheme	Marks	Notes
SC1			B1B1 B1B0 $16+8(T-4)=\frac{1}{2}\times 4(T-4)^2$ M1A1A1 $T^2-12T+24=0$ (or equivalent) A1 $T=6+2\sqrt{3}=9.5$ M1A0 (marking the T as a misread)
SC2			B1B1 B0B0 $16+8(T-4)=\frac{1}{2}\times 4T^2$ M1A1A1 $2T^2-8T+16=0$ A0M0A0 (completely changed the question but some evidence of correct thinking)

Question Number	Scheme	Marks	Notes
4a	Resolve perpendicular to the surface	M1	Condone sin/cos confusion
	$R = 2g\cos\alpha$ (15.68)	A1	Correct resolution
	$F = \frac{1}{4}R = \frac{2g}{5} = 3.9$ N or 3.92 N	A1	Max 3 sf for decimal answer
		(3)	
4b	$-2g\sin\alpha - F = 2a$	M1	Equation of motion parallel to the plane. Require all terms and dimensionally correct. Condone sign errors and sin/cos confusion
		A1ft	Correct unsimplified equation in F (or their F)
	$\frac{-4g}{5} = a$	A1	Or $-7.84\,(\text{m s}^{-2})$ Accept +/-
	$0^2 = 6^2 - \frac{8g}{5}s$	DM1	Complete method using *suvat* and $a \neq g$ to find s Dependent on the previous M1
	$s = \frac{45}{2g} = 2.3$ m or 2.30 m	A1	Max 3 sf
		(5)	
4c	$2g\sin\alpha - F = 2a'$	M1	Equation for motion down the plane to find new acceleration. Require all terms and dimensionally correct. Condone sign errors and sin/cos confusion
		A1ft	Correct unsimplified equation in F (or their F)
	$\frac{2g}{5} = a'$	A1	Or $3.92\,(\text{m s}^{-2})$
	$v^2 = \frac{4g}{5}\frac{45}{2g} = 18 \Rightarrow$	DM1	Complete method using *suvat*, $a' \neq g$ and $a' \neq a$, to find v Dependent on the previous M1
	$v = \sqrt{18} = 4.2$ m s^{-1}(or better)	A1	g cancels Condone 4.25 (from using rounded values).
		(5)	
		[13]	

Question Number	Scheme	Marks	Notes
5a	Correct equation for $\mathbf{v}_P$ or find displacement	M1	Use of $\mathbf{r}_P = \mathbf{r}_0 + \mathbf{v}_P t$ to find $\mathbf{v}$. Allow for $\lambda(-\mathbf{i}-5\mathbf{j})$
	$\mathbf{v}_P = 3(6\mathbf{i}-(7\mathbf{i}+5\mathbf{j})) = -3\mathbf{i}-15\mathbf{j}$	A1	
	$\sqrt{(-3)^2+(-15)^2}$	M1	Use of Pythagoras to find magnitude of their $\mathbf{v}$
	$= \sqrt{234} = 15.3 \left(\text{km h}^{-1}\right)$ (or better)	A1	CSO $\left(3\sqrt{26}\right)$ A0 if it comes from $3\mathbf{i}+15\mathbf{j}$
			NB Could score the M marks in reverse order - find displacement in 20 minutes and then multiply by 3
		(4)	
5b	Use of $\mathbf{r}_P = \mathbf{r}_0 + \mathbf{v}_P t$: $\mathbf{r}_P = 7\mathbf{i}+5\mathbf{j}+t(-3\mathbf{i}-15\mathbf{j})$	M1	For their $\mathbf{v}_P$
	$\Rightarrow \mathbf{r}_P = (7-3t)\mathbf{i}+(5-15t)\mathbf{j}$	A1	Obtain **given answer** from correct working
		(2)	
5c	$\dfrac{(7-3t)}{(5-15t)} = \dfrac{16}{5}$	M1	Use given answer and direction to form equation in t
		A1	Correct unsimplified equation
	$35-15t = 80-240t$	DM1	Solve for t. Dependent on the previous M1
	$t = 0.2$	A1	
		(4)	
5d	P and Q in the same place at the same time	M1	Equate **i** or **j** components of position vectors and solve for t
	$\Rightarrow\ 7-3t = 5+2t$ or $5-15t = -3+5t$	A1	Either
	$t = 0.4$	A1	
	Check that the same value of t gives equal values for the other component	DM1	Dependent on the previous M mark
	$\mathbf{r} = (5.8\mathbf{i}-\mathbf{j})$ km	A1	Must be a vector
		(5)	
		[15]	

Question Number	Scheme	Marks	Notes
			
6a	For the trailer:	M1	Complete method to form an equation in T. e.g. equation of motion for the trailer. Need all 3 terms. Condone sign errors.
	$-100-T=600\times(-4)$	A1	Correct unsimplified equation. Allow with $\pm T$
	$T=2300$ N	A1	Must be positive
		(3)	
6b	For the car and trailer:	M1	Complete method to solve for M. Equation of motion for the car + trailer. Need all terms. Condone sign errors.
	$6500+100+200=4(M+600)$	A1	Correct unsimplified equation
	$M=1100$	A1	
			Allow M1A1 if a correct equation is seen in (a) and used in (b)
6balt	For the car:	M1	Equation of motion for the car. Need all terms. Condone sign errors.
	$6500+200-T=4M$	A1	Correct unsimplified equation in T or their T
	$M=1100$	A1	
		(3)	
6c	$s=vt-\frac{1}{2}at^2$	M1	Complete method using s*uvat* to find t Clear use of $s=ut+\frac{1}{2}at^2$ with $u=0, a=4$ is M0. e.g. $40.5=-2t^2$ from no working is M0A0
	$40.5=\frac{1}{2}.4.t^2$	A1	Correct unsimplified equation
	$t=4.5$ s	A1	
		(3)	
		[9]	

Question Number	Scheme	Marks	Notes
7a	$\sin\alpha = \frac{3}{5}$ or $\cos\alpha = \frac{4}{5}$	B1	Correct trig ratios for α seen or implied Watch out - it could be up beside the diagram
	At B, $(\uparrow)$	M1	Complete method to form equation in T_{AB}
	$\Rightarrow \quad T_{AB}\sin\alpha = 3g$	A1	Correct unsimplified equation
	$T_{AB} = 5g = 49$ N	A1	
		(4)	
7b	At B, $(\rightarrow)$	M1	Complete method to form equation in T_{BC}
	$\Rightarrow \quad T_{AB}\cos\alpha = T_{BC}$	A1	Correct unsimplified equation. Allow with their T_{AB}
	$T_{BC} = 4g = 39$ or 39.2 N	A1	
		(3)	
7c	Resolve at C:	M1	Resolve to form equation in T_{CD} There is a lot of confusion over the labelling of the tensions. Allow if a value is used correctly, whatever it is called.
	At C, $(\rightarrow)$ $T_{CD}\cos\beta = T_{BC}$	A1	One correct equation in T_{CD} Could be whole system equations e.g. $T_{AB}\cos\alpha = T_{CD}\cos\beta$ $T_{AB}\sin\alpha + T_{CD}\sin\beta = (3+M)g$
	At C, $(\uparrow)$ $T_{CD}\sin\beta = Mg$	A1	Two correct equations in T_{CD} (=101.92)
	$\tan\beta = \dfrac{Mg}{T_{BC}}$	DM1	Dependent on previous M1. Use $\tan\beta$ and solve for M
	$Mg = 4g \times \frac{12}{5} \Rightarrow M = 9.6$	A1	
		(5)	
		[12]	

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