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Mark Scheme (Results)

Summer 2015

Pearson Edexcel International A Level in Mechanics 1 (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.

- 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. 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

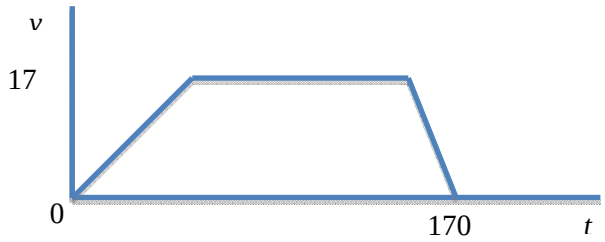
  SHM Simple harmonic motion

  PCLM Principle of conservation of linear momentum

  RHS, LHS Right hand side, left hand side.

Question Number	Scheme	Marks	Notes
1.	$(2\mathbf{i} + 3a\mathbf{j}) + (2a\mathbf{i} + b\mathbf{j}) + (b\mathbf{i} + 4\mathbf{j}) = \mathbf{0}$	M1	Use of resultant force = 0 (Seen or implied)
	$2a + b + 2 = 0;\ 3a + b + 4 = 0$	M1	In an equation involving all three forces once and once only, compare **i** or **j** components to form an equation in a and b. Allow with **i** or **j**. $\lambda\mathbf{i} = \mu\mathbf{j}$ is M0
		A1	Two correct scalar equations. No i/j
	$a = -2; b = 2$	DM1	Solve simultaneous equations to find a or b. Dependent on the previous M1
		A1	a correct
		A1	b correct
		6	
2(a)	$2mu - km3u = -2m\frac{1}{2}u + kmv$	M1	Conservation of momentum. Must have all four terms but condone sign errors and consistent omission of m or g included in all terms
	$(3u = kv + 3ku)$	A2,1,0	-1 for each error. All correct A1A1, one error A1A0, two or more errors A0A0
	$v = (1-k)\frac{3u}{k}$ or $k = \frac{3u}{v+3u}$	A1	Correct expression for v or for kv or for k
	$v > 0 \Rightarrow$	M1	Correct inequality for their v
	$\Rightarrow k < 1$ *	A1	Reach **given answer** correctly
		(6)	
(b)	$I = 2m(\frac{1}{2}u - -u)$	M1	Impulse = <u>change</u> in momentum for A or for B. Condone sign errors.
		A1	Correct unsimplified expression in terms of m and u. Allow +/-
	$= 3mu$	A1	Correct answer only.
		(3)	
		9	

3(a)	$5.5 = \frac{1}{2}a.2^2$	M1	Complete method using *suvat* equations to form an equation in *a* only
	$\Rightarrow a = 2.75$	A1	
		(2)	
(b)	$R = 30\sin\alpha + 2g\cos\alpha$	M1	Resolve perpendicular to the plane to find an expression for *R*. Must have all terms. Condone sign errors and sin/cos confusion.
		A2	-1 each error. All correct A1A1, one error A1A0, two or more errors A0A0 ($R = 33.68$)
	$-F + 30\cos\alpha - 2g\sin\alpha = 2\ a$	M1	Equation of motion parallel to the plane with *a* or their *a*. Must have all terms. Condone sign errors and sin/cos confusion.
		A2	-1 each error ($F = 6.74$)
	$\mu = \dfrac{30\cos\alpha - 2g\sin\alpha - 5.5}{30\sin\alpha + 2g\cos\alpha}$	DM1	Use $F = \mu R$ Dependent on the 2 previous M marks
	$= 0.200$ or 0.20	A1	Do not accept 0.2
		(8)	
		10	
4.		M1	Use $s = ut + \dfrac{1}{2}at^2$ or a complete *suvat* route to find h in terms of t
	$h = \frac{1}{2}gt^2$	A1	Or $h = \frac{1}{2}g(t+1)^2$. The expression for time used in the first equation defines the expression expected in the second equation.
	$h = 19.6(t-1) + \frac{1}{2}g(t-1)^2$	A1	Or $h = 19.6(t) + \frac{1}{2}g(t)^2$ or $h = 4.9 + \left(9.8t + \dfrac{1}{2}gt^2\right)$
	$\frac{1}{2}gt^2 = 19.6(t-1) + \frac{1}{2}g(t-1)^2$	M1	Equate the two expressions for *h*.
		DM1	Solve for *t*. Dependent on the previous M1.
	$t = 1.5$	A1	Using the "Or" approach gives $t = 0.5$
	$h = 11$ m or 11.0 m	A1	Accept 2 or 3 s.f. only
		7	

5(a)		B1	shape
		B1	rel grad - RHS steeper than LHS
		B1 (3)	17 and 170 shown
(b)	$T;2T$	B1	Correct ratios of times for acceleration and deceleration seen or implied.
	$\frac{170+(170-3T)}{2}17=2125$ Or $\frac{1}{2}\times T_1\times 17+17(170-(T_1+T_2))+\frac{1}{2}\times 17\times T_2=2125$ Or $2125=\frac{17}{2}(170+T')$	M1	Form an equation for total distance with their times
		A2	-1 each error
	$T=30$ Or $T_1+T_2=90$	A1	Use their equation and the correct ratio to find the value for time decelerating or the total of time accelerating and decelerating
		M1	Use of $v=u+at$ or equivalent
	decel $=\frac{17}{30}$ oe	A1	$(0.5\dot{6})$ 3sf or better. Must be positive.
		(7)	
		10	

Question Number	Scheme	Marks	Notes
6(a)		M1	Resolve vertically to form an equation in R_C or R_D . All terms required. Condone sign errors.
	$2T + T = 6g + 15g$	A1	Correct unsimplified equation ($R + \frac{1}{2}R = 6g + 15g$)
	$2T = 14g = 137$ N or 140 N	A1	
		(3)	
(b)		M1	Take moments - all terms must be present and of the correct structure. Form an equation with one unknown length.
	$M(A)$ 15g AX + 6g x 2 = ($2T$ x 1.5) + $4T = 7T$ $M(B)$ $15gd + 6g \times 2 = 2T \times 2.5$ M(c of m) $2T \times 0.5 + 15gd = 2 \times T$ $M(C)$ $6g \times 0.5 + 15g\left(x - 1.5\right) = T \times 2.5$	A2	-1 each error. Follow their T NB: Use of the correct reactions the wrong way round is one error. $\left(15g \approx 147,\ 6g \approx 58.8,\ 12g \approx 117.6\right)$
		M1	Substitute for T and solve for AX
	$AX = \frac{37}{15}$ m = 2.5 m (or better)	A1	$2.4\dot{6}$
		(5)	
	NB: If you see parts (a) and (b) merged, award the 8 marks as bM1 for the first moments equation bA2 for the equation correct aM1 for a second moments equation and an attempt to solve for R_C aA1 for the second equation correct aA1 for the reaction correct bM1 and bA1 as above		
(c)	$M(C)$, 15g YC = 6g x 0.5	M1	Requires both terms present and of the correct structure. No additional terms (Using $R_C = 21g, R_B = 0$)
		A1	Correct unsimplified equation
	YC = 0.2 m	A1	
	$AY = 1.3$ m	A1	
		(4)	See over for Alt (c)
		12	

Alt (c)	$M(A)$: $15gAY + 6g \times 2 = 1.5 \times 21g$	M1	Requires all terms present and of the correct structure. No additional terms
		A2	Correct unsimplified equation -1 each error
	$AY = 1.3$ m	A1	
		(4)	
Alt (c)	$M(C)$: $6g \times 0.5 = 15g(1.5 - AY)$	M1	
		A2	-1 each error
	$AY = 1.3$ m	A1	
		(4)	
7.	$(2\mathbf{i} + 9\mathbf{j}) - (-3\mathbf{i} - 3\mathbf{j})$	M1	Use of $\mathbf{v} - \mathbf{u}(= \mathbf{a}t)$ seen or implied
	$= (5\mathbf{i} + 12\mathbf{j})$	A1	
	$k^2(5^2 + 12^2) = 2.6^2 \quad (k = 1/t)$	M1	Use magnitude = 2.6 = $k\lvert\mathbf{a}\rvert$ (linking 2.6 & 13)
	$c = 5\text{x}0.2 = 1$	A1	
	$d = 12\text{x}0.2 = 2.4$	A1	
		(5)	

8(a)	$R = mg$	B1	Forces acting vertically on P
	$F = 0.5R$	B1	Use of $F = \mu R$
		M1	One equation of motion. Requires all terms but condone sign errors
	$4mg - T = \pm 4ma$	A1	
		M1	A second equation of motion of P. Requires all terms but condone sign errors
	$T - F = \pm ma$	A1	Signs of a must be consistent
			Condone use of $4mg - F = 5ma$ in place of either of the above equations.
	$4mg - 0.5mg = 5ma$ $a = 0.7g$ or $4mg - T = 4T - 2mg$	DDM1	Solve for T Dependent on the two preceding M marks
	$T = 1.2mg$	A1	
		(8)	
(b)	$v^2 = 2 \text{ x } 0.7\text{gh}$	M1	Complete method to an equation in v or v^2
	$v = \sqrt{1.4gh}$ *	A1	Obtain **given answer** or exact equivalent from exact working with no errors seen.
		(2)	
(c)	$-0.5mg = ma'$	M1	Complete method to find the deceleration of P
	$\Rightarrow a' = -0.5g$	A1	
		M1	Complete method to find additional distance on terms of h $\left(a \neq 0.7g, a \neq g\right)$
	$0^2 = 1.4gh - 2 \text{ x } 0.5g \text{ x } d$	A1	Correctly substituted equation. Follow their $a \neq 0.7g$, $a \neq g$.
	$d = 1.4h$	A1	
	Hence, length of string is greater than $1.4h + h = 2.4h$	A1	Obtain **given answer** with no errors seen. Their statement needs to reflect the inequality.
		(6)	
		16	

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