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Mark Scheme(Results)

October 2016

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.
- 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.

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)

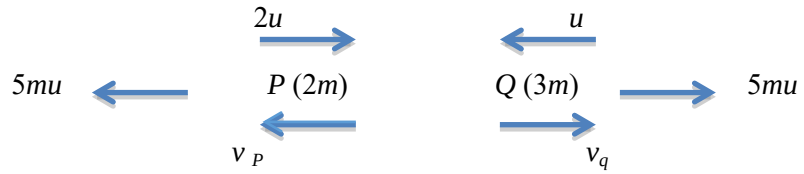
  NEL Newton's Experimental Law (Newton's Law of Impact)

  HL Hooke's Law

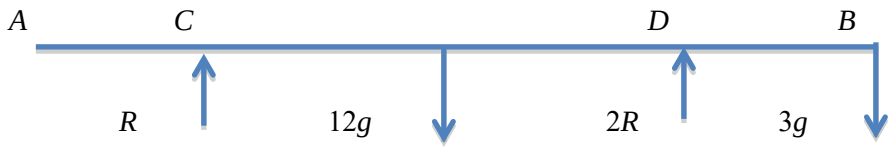
  SHM Simple harmonic motion

  PCLM Principle of conservation of linear momentum

  RHS, LHS Right hand side, left hand side.

Question Number	Scheme	Marks
1.(a)	 $5mu = 2m(v_P - -2u)$ $v_P = \frac{1}{2}u$	M1 A1 A1 (3)
(b)	Reversed	B1 (1)
(c)	$5mu = 3m(v_Q - -u)$ $v_Q = \frac{2}{3}u$ **OR** $2m2u - 3mu = -2m\frac{1}{2}u + 3m\ v_Q$ $v_Q = \frac{2}{3}u$	M1 A1 A1 (3) **OR** M1 A1 A1 (3) **7**
	Notes	
1.(a)	First M1 for a complete method to find v_P (M0 for CLM only, with 2 unknowns) for use of $5mu$ = change in momentum of P (must have $2m$ in both terms) (M0 if *clearly* adding momenta) but condone sign errors. First A1 for a correct equation in v_P only. Second A1 for ½ u (A0 if –ve)	
1.(b)	B1 for reversed – only allow if ½ u or - ½ u has been correctly obtained in (a). Allow: '(Yes) it has' but NOT just 'Yes' nor 'has been changed' nor just "opposite"	
1.(c)	First M1 for a complete method to find v_Q (M0 for CLM only, with 2 unknowns) for use of $5mu$ = change in momentum of Q (must have $3m$ in both terms) (M0 if *clearly* adding momenta) but condone sign errors. First A1 for a correct equation in v_Q only. Second A1 for $\frac{2}{3}u$ or $0.67u$ or better (A0 if –ve) **OR** First M1 for a complete method to find v_Q for use of CLM with correct no. of terms and their v_P (M0 for CLM only, with 2 unknowns) but condone sign errors. First A1 for a correct equation in v_Q only. Second A1 for $\frac{2}{3}u$ or $0.67u$ or better (A0 if –ve) **N.B.** They may find v_Q first i.e. do (c) first, then use CLM in (a).	

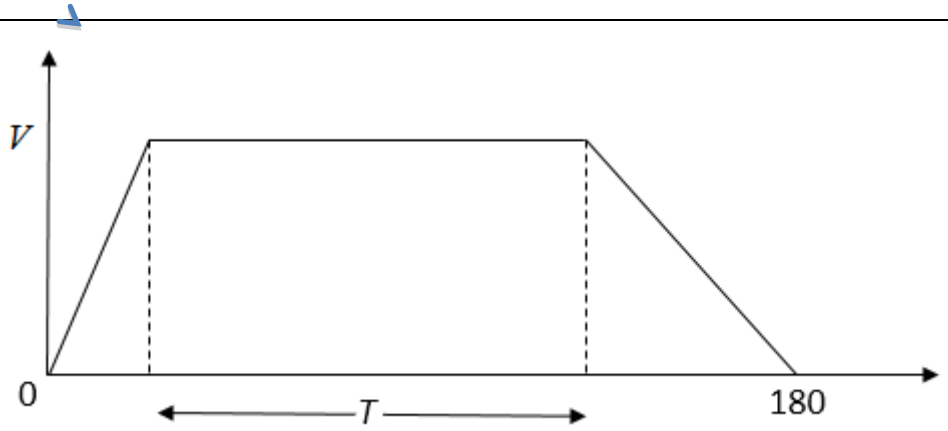
Question Number	Scheme	Marks
2(a)	$(-10\mathbf{i}+a\mathbf{j})+(b\mathbf{i}-5\mathbf{j})+(2a\mathbf{i}+7\mathbf{j}) = 3(3\mathbf{i}+4\mathbf{j})$ $a-5+7=12 \Rightarrow a=10$ $-10+b+2a=9 \Rightarrow b=-1$	M1 M1 A1 M1 A1 (5)
(b)	$20\mathbf{i}+20\mathbf{j}=\mathbf{u}+4(3\mathbf{i}+4\mathbf{j})$ $\mathbf{u}=(8\mathbf{i}+4\mathbf{j})$ $u=\sqrt{8^2+4^2}=\sqrt{80}=8.9$ (or better)	M1 A1 M1 A1 **(**4) **9**
	Notes	
2(a)	First M1 for applying **F** = *m***a**; need all terms but allow slips and allow *m* instead of 3 Second M1 (independent but M0 if they have **0** instead of *m***a**) for equating *coefficients* of **j** First A1 for $a = 10$ Third M1 (independent but M0 if they have **0** instead of *m***a**) for equating *coefficients* of **i** Second A1 for $b = -1$	
(b)	First M1 for applying **v** = **u** + *t***a**; need all terms and must be vector **u** First A1 for 8**i** + 4**j** Second M1 (independent) for finding magnitude of their vector **u** Second A1 for √80 or 8.9 or better	

Question Number	Scheme	Marks
3.	 $(\uparrow)\quad R+2R=12g+3g$ $M(A),\quad 2Rx+3R=12g.4+3g.8$ $x=5.7$	M1 A2 M1 A2 A1 **7**
	Notes	
	First M1 for either a vertical resolution (with correct of terms) or a moments equation (all terms dim correct and correct no. of terms) First A1 and Second A1 for a correct equation in R (or S where $S = 2R$) only or R and x only or S and x only. (-1 each error , A1A0 or A0A0) Second M1 for either a vertical resolution (with correct of terms) or a moments equation (all terms dim correct and correct no. of terms) Third A1 and Fourth A1 for a correct equation in R (or S where $S = 2R$) only or R and x only or S and x only. (-1 each error, A1A0 or A0A0) Fifth A1 for $x = 5.7$ oe **N.B. On ePen, first 3 marks are for a vertical resolution, if it appears, second 3 marks are for a moments equation.** **If no vertical resolution, award marks as they appear for the (two) moments equation(s).** **(i)** In a moments equation, if R and $2R$ (or S and $0.5S$) are interchanged, treat as 1 error. **(ii)** Ignore diagram if it helps the candidate. **(iii)** If an equation is correct but contains both R and S, treat as 1 error. **(iv)** Full marks possible if all g's omitted. **(v)** For inconsistent omission of g, penalise each omission. $M(B),\ R\times 5+S(8-x)=12g\times 4$ $M(C),\ S(x-3)=12g\times 1+3g\times 5$ $M(D),\ R(x-3)+3g(8-x)=12g(x-4)$ **N.B. If they use a different variable, other than *x, for a length, with it clearly marked on the diagram,* they can score all the marks for any moments equation.**	

Question Number	Scheme	Marks
4.(a)	$\mathbf{p} = (-5\mathbf{i} + 9\mathbf{j}) + t(\mathbf{i} - 2\mathbf{j})$	M1 A1 (2)
(b)	$2 = 9 - 2t$ $t = 3.5$ $\mathbf{p} = (-5\mathbf{i} + 9\mathbf{j}) + 3.5(\mathbf{i} - 2\mathbf{j}) = (-1.5\mathbf{i} + 2\mathbf{j})$	M1 A1 M1 A1 (4)
(c)	$\frac{2b-1}{5-2b} = \frac{1}{-2}$ $b = -1.5$	M1 A1 **DM1** A1 (4) **10**
	Notes	
4.(a)	M1 for clear attempt at $\mathbf{p} = (-5\mathbf{i} + 9\mathbf{j}) + t(\mathbf{i} - 2\mathbf{j})$ (allow slips but must be ' + ') A1 if correct	
(b)	First M1 for equating the **j** *component* of their **p** to 2 First A1 for $t = 3.5$ Second M1 (independent) for substituting their t value into their **p** Second A1 for (-1.5**i** + 2**j**)	
(c)	First M1 for $\frac{2b-1}{5-2b} = \pm\frac{1}{2}$ or $\frac{2b-1}{5-2b} = \pm\frac{2}{1}$ (must be in b only but allow slips) First A1 for a correct equation in b only Second M1 (dependent on first M1) for solving for b Second A1 for b = -1.5	

Question Number	Scheme	Marks
5(a)	($\square$), $R = 8\cos 50^o + 0.5g\cos 30^o$ ($\square$), $F = 8\cos 40^o - 0.5g\sin 30^o$ $F = \mu R$ $\mu = 0.39$ or 0.392	M1 A2 M1 A2 B1 **DM1** A1 **9**
	Notes	
	First M1 for resolving perpendicular to the plane with usual rules and 8 must be used with 40^o or 50^o and 0.5(g) must be used with 30^o or 60^o First A1 and second A1 for a correct equation – 1 each error (A1A0 or A0A0) Second M1 for resolving parallel to the plane with usual rules and 8 must be used with 40^o or 50^o and 0.5(g) must be used with 30^o or 60^o Third A1 and fourth A1 for a correct equation – 1 each error (A1A0 or A0A0) B1 for $F = \mu R$ seen Third M1 dependent on both previous M marks for solving for μ Fifth A1 for 0.39 or 0.392 **N.B. If they resolve in any other directions e.g. horizontally or vertically, apply similar rules to the above for the M mark in each case.**	

Question Number	Scheme	Marks
6.	$s_A = 35t + \frac{1}{2}0.4t^2; s_B = 44t + \frac{1}{2}0.5t^2$ $44t + \frac{1}{2}0.5t^2 = 200 + 35t + \frac{1}{2}0.4t^2$ $\frac{1}{20}t^2 + 9t - 200 = 0$ $(t-20)(t+200) = 0$ $t = 20$ $v = 44 + \frac{1}{2}.20 = 54 \text{ ms}^{-1}$	M1 A1 A1 M1 A1 M1 A1 **DM1** A1 **9**
	Notes	
	First M1 for use of $s = ut + \frac{1}{2}at^2$ for either *A* or *B* First A1 for a correct equation for *A* Second A1 for a correct equation for *B* Second M1 for producing a quadratic in *t* only from their s_A = their $s_B \pm 200$ Third A1 for a correct '3 term = 0' equation Third M1 (can be implied by one correct answer) for attempt to solve their quadratic (M0 if linear). Must include 200, must be 3 terms and must have come from using both distance expressions. Fourth A1 for $t = 20$ Fourth M1 dependent on third M1 for correctly using their *t* value to find *v* Fifth A1 for 54 **N.B. SC for trial and error to find *t* ; can score max M1A1A1M1A0M0A0M1A1 6/9**	

Question Number	Scheme	Marks
7.(a)		B1 shape B1 figs. (V,T,180) (2)
(b)	Time accelerating = $V/1 = V$ Time decelerating = $V/0.5 = 2V$ Time at constant speed, $T = 180 - (2V + V)$ $T = 180 - 3V$ **Printed answer**	M1 A1 (2)
(c)	$\frac{1}{2}(180+180-3V)V = 4800$ $V^2 - 120V + 3200 = 0$ $(V-40)(V-80) = 0$ $V = 40$ or 80 or both, since $(180 - 3 \times 80) < 0$	M1 A1 A1 A1 **DM**1 A1, M1 (7) **11**
	Notes	
7.(a)	First B1 for a trapezium, starting at the origin and finishing on the t-axis. Second B1 for V, T with delineators or marked on the top of the trapezium or oe and 180 correctly positioned.	
(b)	M1 for both Time accelerating = $V/1 = V$ and Time decelerating = $V/0.5 = 2V$ M0 if no working for the $2V$ as it's a 'Show that' or if they use $V/ - 0.5$ and fudge the –ve sign A1 for $T = 180 - (2V + V) = 180 - 3V$ **Printed answer**	

(c)	First M1 for attempt at using area under graph = 4800, with appropriate terms, to produce an equation in V only; must have used $\frac{1}{2}$ somewhere. (M0 if one *suvat* formula used) First A1 and second A1 for a correct equation (A1A0 one error) Third A1 for a correct quadratic expression = 0 Second M1 dependent on first M1 for solving their quadratic (can be implied by 1 correct answer) Fourth A1 for $V = 40$ or $V = 80$ or both Third M1 for a correct reason for rejecting $V = 80$. (only available if both correct values have been obtained) Allow: "Since $T > 0$, $V = 40$" oe	

Question Number	Scheme	Marks
8(a)	$1.4^2 = 2a \times 0.5 \Rightarrow a = 1.96 \text{ ms}^{-2}$ $3g - T = 3a$ or $-3a$ $T = 23.5 \text{ N}$ or $24 N$	M1 A1 M1 A1 A1 (5)
(b)	$F = \mu R$ $R = 2g\cos\alpha$ $T - 2g\sin\alpha - F = 2a$ or $-2a$ $\mu = 0.5$	B1 M1 A1 M1 A1 A1 **DM**1 A1 (8) **13**
	Notes	
8(a)	First M1 for using one or more *suvat* formulae to produce an equation in a only First A1 for 1.96 (or -1.96 but only if correctly used in the second equation, in which case they *could* score 5/5) Second M1 for resolving vertically for Q (correct no. of terms but condone sign errors) Second A1 for a correct equation provided a used consistently in their two equations (but a does not need to be substituted) **N.B.** If they haven't found a value for a, the A1 can be scored for either $3a$ or $-3a$ in the equation of motion. Third A1 for 23.5 or 24	
(b)	B1 for $F = \mu R$ seen First M1 for resolving perpendicular to the plane (correct no. of terms with $2g$ resolved) First A1 for a correct equation (M1A0 for $R = mg\cos\alpha$) Second M1 for resolving parallel to the plane (correct no. of terms with $2g$ resolved but condone sign errors) Second A1 and third A1 for a correct equation (A1A0 for one error) N.B. Neither T nor F nor a needs to be substituted. Third M1 dependent on both previous M marks, for solving for μ(a *numerical* value) Fourth A1 for $\mu = 0.5$ (A0 for 0.499)	

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