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Mark Scheme (Results)

January 2016

Pearson Edexcel International A Level in Mechanics 1 (WME01)

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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 GCE 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

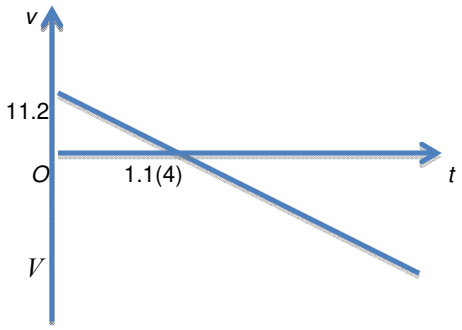
  PCLM Principle of conservation of linear momentum

  RHS, LHS Right hand side, left hand side.

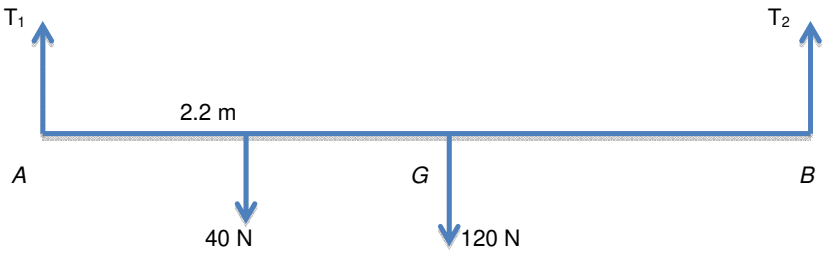
Question Number	Scheme	Marks
1(a)	For truck: $D - 600 - 400 = 2400$ x 0.5 $D = 2200$N	M1 A1 A1 (3)
(b)	For both: $D - 600 = (M + 2400)$ x 0.5 (or trailer: 600 - 200 = M x0.5) $M = 800$ $M = 800$	M1 A1 A1 (3)
(c)	Truck and trailer have same acceleration.	B1 (1) **7**
	Notes **Can mark (a) and (b) 'together' if it helps the candidate, provided no wrong working seen.**	
1(a)	M1 for NL2 for truck only (or for a complete method if they find *M* first), with correct no. of terms, in *D* only. (M0 if 600 or 400 is replaced by 200) First A1 for a correct equation . Second A1 for 2200 (N). .	
1(b)	M1 for NL2 for whole system or trailer only, with correct no. of terms. First A1 for a correct equation. (Allow '*D*' or their *D*) Second A1 for 800. **N.B.** In both parts of this question use the mass which is being used in their equation to guide you as to which part of the system is being considered.	
1(c)	B0 if extras included. E.g if 'tension is same' is included. B1 Must include 'truck and trailer' or 'both particles' or 'accln is same throughout the system' B0 for 'accln is same'	

Question Number	Scheme	Marks
2(a)	$For P: \quad \frac{33}{5}mu = 2m(-v_P - -4u)$ $v_P = 0.7u$ due E	M1 A1 **dM1** A1 (4)
(b)	$For Q: \quad \frac{33}{5}mu = 3m(v_Q - -u)$ $v_Q = 1.2u$ due E	M1 A1 **dM1** A1 (4)
	Notes	
2(a)	**(c)**	
2(b)	First M1 for attempt at impulse = difference in momenta, for Q only, (i.e. must be using $3m$ and u). M0 if g's are included on RHS First A1 for either $^{33}/_5\ mu = 3m(v_Q - -u)$ or $^{33}/_5\ mu = 3m(-v_Q - -u)$ oe Second dM1 for answer $^{c}/_5\ u$, where c is an integer, oe Second A1 for $1.2u$ oe due E (or 'reversed' or 'original direction of P') But A0 if just 'changed' or 'to the right' or 'in positive direction'	
2(b) **ALT**	First M1 for attempt at CLM equation, with correct no. of terms, dimensionally correct, with their v_P substituted. Allow consistent extra g's and cancelled m's and sign errors but masses and velocities must be correctly matched. First A1 for $2m.4u - 3mu = 2m.0.7u + 3m\ v_Q$ oe or $2m.4u - 3mu = 2m.0.7u - 3m\ v_Q$ oe Second dM1 for answer $^{c}/_5\ u$, where c is an integer, oe Second A1 for $1.2u$ oe due E	
2(a) **ALT**	They may find v_Q first, then First M1 for attempt at CLM equation, with correct no. of terms, dimensionally correct, with their v_Q substituted. Allow consistent extra g's and cancelled m's and sign errors but masses and velocities must be correctly matched. First A1 for $2m.4u - 3mu = 2mv_P + 3m \times 1.2u$ oe or $2m.4u - 3mu = -2mv_P + 3m \times 1.2u$ oe Second dM1 for answer $^{k}/_{10}\ u$, where k is an integer, oe Second A1 for $0.7u$ oe due E (or unchanged)	

Question Number	Scheme	Marks
3	$F = 0.2R$ $R + T\sin 30^o = 8g$ $F = T\cos 30^o$ $0.2(8g - T\sin 30^o) = T\cos 30^o$ $T = 16$ N or 16.2 N	B1 M1 A1 M1 A1 **ddM1** **dM1** A1 **8**
	Notes	
	B1 for $F = 0.2R$ or $F = \mu R$ <u>*and*</u> $\mu = 0.2$, seen (could just be on a diagram). First M1 for resolving vertically with correct no. of terms and T resolved (allow missing g). First A1 for a correct equation. Second M1 for resolving horizontally with correct no. of terms and T resolved. (M0 if there is an 'ma' term which does not subsequently disappear.) Second A1 for a correct equation. Third ddM1 (dependent on both previous M's) for producing an equation in T only. Fourth dM1 (dependent on previous M) for solving for T Third A1 for $T = 16$ (N) or 16.2 (N) No other answers.	

Question Number	Scheme	Marks
4(a)	$0^2 = 11.2^2 - 2gd$ $d = 6.4$ max ht. $= 3.6 + 6.4 = 10$ m	M1 A1 A1 A1 (4)
ALT	$11.2^2 = u^2 - 2g$ x 3.6 $u = 14$ $0^2 = 14^2 - 2gh$ $h = 10$ m	M1 A1 A1 A1 (4)
(b)	$10 = \frac{1}{2}gt^2$ $t = \frac{10}{7}$ Total $= 2\text{x}\frac{10}{7} = 2.9$ or 2.86	M1 A1 A1 **dM1** A1 (5)
(c)		B1 single line **dB1** $V <$ -11.2 B1 11.2 B1 1.1(4) (4) **13**
	Notes	
4(a)	M1 for a complete method to find d (d = distance from A to top) First A1 for a correct equation in d only. Second A1 for $d = 6.4$ Third A1 for 6.4 + 3.6 = 10 (m)	
ALT	M1 for a complete method (must have 2nd equation) to find h First A1 for $u = 14$ Second A1 for correct 2nd equation Third A1 for $h = 10$ (m)	
4(b)	First M1 for a complete method to find an intermediate time (A to top or A to O) First A1 for a correct equation or equations. Second A1 for any intermediate time (e.g. $_At_{TOP} = {}^8/_7$, $_At_O = {}^2/_7$, $_At_O = {}^{18}/_7$, $_At_A =$	

	16/7) Second **dM1** for a complete method to find the total time. Third A1 for 2.9 or 2.86 (s) No other final answers. For a *complete* method which does not involve an intermediate time e.g find u (=14) at O, then use u to find the whole time: First **dM1** dependent on 2nd M1, for finding u First A1 for $u = 14$ Second M1 for: $0 = 14t - 1/2gt^2$ or $-14 = 14 - gt$ Second A1 Third A1 for t =2.86 or 2.9	
4(c)	First B1 for a SINGLE straight line (N.B. If they have a continuous vertical line as well, give B0), with –ve gradient, starting on +ve v-axis (at A say) and *crossing* the t-axis. (at B say). **SC**: A single str. line, with –ve gradient, which starts at (2/7, 11.2) (clearly marked) can score a max B1B1B0B0.	
	Second **dB1,** dependent on first B1, for the line finishing at C say, with $AB < BC$ if no scale, or at $v = V$,where $V < -11.2$, if marked.	
	Third B1 (independent) for their (possibly first) line starting at (0,11.2)	
	Fourth B1 (independent) for 1.1(4) (allow 8/7 if over accuracy already penalised elsewhere) marked correctly (line may not cross the axis and there may be more than one line)	
	N.B. Line may be reflected in t-axis, with appropriate adjustments to marks.	

Question Number	Scheme	Marks
5(a)		
(i)	$M(B),\ \ 4T_1 = 120 \text{ x } 1.8 + 40(4-x)$ $T_1 = 94 - 10x$	M1 A1 A1
(ii)	$M(A),\ \ 4T_2 = 120 \text{ x } 2.2 + 40x$ $T_2 = 66 + 10x$	M1 A1 A1 (6)
(b)	$94 - 10x \le 84$ $x \ge 1$ $66 + 10x \le 84$ $x \le 1.8$ $1 \le x \le 1.8$	M1 M1 A1 both CV A1 (4) **10**
	Notes	
5(a)(i) **(ii)**	First M1 for a complete method to find an equation in T_A and x only. First A1 for a correct equation in T_A and x only. Second A1 for $94 - 10x$ Second M1 for a complete method to find an equation in T_B and x only. First A1 for a correct equation in T_B and x only. Second A1 for $66 + 10x$	
5(b)	First M1 for their $T_A \le 84$ or $= 84$ or < 84 to give equation or inequality in x only. (> 84 is M0) Second M1 for their $T_B \le 84$ or $= 84$ or < 84 to give equation or inequality in x only. (> 84 is M0) First A1 for both critical values of x, 1 and 1.8 SEEN. Second A1 $1 \le x \le 1.8$ or $1 \le x$ AND $x \le 1.8$ or [1, 1.8]	

Question Number	Scheme	Marks
6(a)	$\overrightarrow{PQ} = (7\mathbf{i}+5\mathbf{j})-(5\mathbf{i}-3\mathbf{j}) = (2\mathbf{i}+8\mathbf{j})$ $PQ = \sqrt{2^2+8^2} = \sqrt{68} = 8.2$ or better	M1 M1 A1 (3)
(b)	$\mathbf{r}_P = (5\mathbf{i}-3\mathbf{j})+t(2\mathbf{i}+5\mathbf{j}) = (2t+5)\mathbf{i}+(5t-3)\mathbf{j}$	M1 A1 (2)
(c)	$\mathbf{r}_Q = (7\mathbf{i}+5\mathbf{j})+t(-3\mathbf{i}-15\mathbf{j}) = (7-3t)\mathbf{i}+(5-15t)\mathbf{j}$	A1 (1)
(d)	$(2t+5) = (7-3t) \Rightarrow t = \frac{2}{5}$ $(5t-3) = (5-15t) \Rightarrow t = \frac{2}{5}$ time is 2.24 pm Allow just $t = 0.4$	M1 A1 M1 A1 A1 (5)
(e)	$\mathbf{r}_P = (5.8\mathbf{i}-\mathbf{j})$	M1 A1 (2) **13**
	Notes **Allow column vectors throughout.**	
6(a)	First M1 for clear attempt to subtract in either order. Condone missing brackets. Second M1 for attempt to find magnitude of their **PQ** or **QP** A1 √68, 2√17 or 8.2 or better	
(b)	M1 for (either $\mathbf{r}_P$ or $\mathbf{r}_Q$) a clear attempt at: (M0 if they use $(t+2)$) $\mathbf{r}_P = (5\mathbf{i}-3\mathbf{j})+t(2\mathbf{i}+5\mathbf{j}) = (2t+5)\mathbf{i}+(5t-3)\mathbf{j}$ A1 if correct (**i**'s and **j**'s do not need to be collected.)	
(c)	A1 for $\mathbf{r}_Q = (7\mathbf{i}+5\mathbf{j})+t(-3\mathbf{i}-15\mathbf{j}) = (7-3t)\mathbf{i}+(5-15t)\mathbf{j}$	
(d)	First M1 for equating coefficients of **i** (coeffs. of form $a + bt$) First A1 for $t = 2/5$ Second M1 for equating coefficients of **j** (coeffs. of form $a + bt$) Second A1 for $t = 2/5$ Third A1 for 2.24 (pm) , dependent on *both* previous M marks	
(e)	This answer must appear in part (e). M1 for substituting their t value (allow even if they have only equated coefficients once to obtain it) into their $\mathbf{r}_P$ or $\mathbf{r}_Q$ expression A1 for $\mathbf{r}_P = (5.8\mathbf{i}-\mathbf{j})$	

Question Number	Scheme	Marks
7(a)	$T - F = 2a$	M1 A1 (2)
(b)	$5g\sin\alpha - T = 5a$	M1 A1 (2)
(c)	$R = 2g$ $F = \frac{1}{4}R$ $a = \frac{5g}{14} = 3.5 \text{ ms}^{-2}$ $T = 11.9 \text{ N}$ or 12 N	B1 B1 M1 A1 A1 (5)
(d)	$v^2 = 2 \text{ x } 3.5 \text{ x } 0.5 = 3.5$ $(\rightarrow) \ -0.5g = 2a \Rightarrow a = -0.25g \ (-2.45)$ $0 = 3.5 + 2(-2.45)s$ $s = \frac{5}{7}$ (0.7142..) $d = \frac{1}{2} + \frac{5}{7} = \frac{17}{14} = 1.2$ or 1.21	M1 A1 **ft** M1 A1 M1 A1 A1 **ft** (7) **16**
	Notes	
7(a)	M1 for N2L for P with correct no. of terms etc. A1 for a correct equation	
(b)	M1 for N2L for Q with correct no. of terms etc. A1 for a correct equation	
(c) **(i)** **(ii)**	First B1 for $R = 2g$ Second B1 for $F = ¼ R$ seen, possibly on a diagram First M1 for eliminating T or a and solving for T or a but must have had two equations, each in T *and* a. First A1 for 5g/14 or 3.5 or 7/2 (ms^{-2}) Second A1 for 17g/14 , 11.9 or 12 (N)	
(d)	First M1 for a complete method for finding v or v^2 when the string breaks. First A1 **ft** for a correct expression (may not be evaluated), ft on their accln Second M1 for N2L for P Second A1 for a correct value of a (may not be negative) Third M1 (Must have found a deceleration using N2L and a value for v or v^2) for a complete method to find distance moved by P Third A1 for a correct distance (s) cao. Fourth A1 **ft** for (their s + 0.5) **N.B.** For both third and fourth A marks, allow a fraction or any number of decimal places, since g cancels.	

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