Pearson

Mark Scheme (Results)

October 2017

Pearson Edexcel International A Level
in Mechanics M1 (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 √ 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.

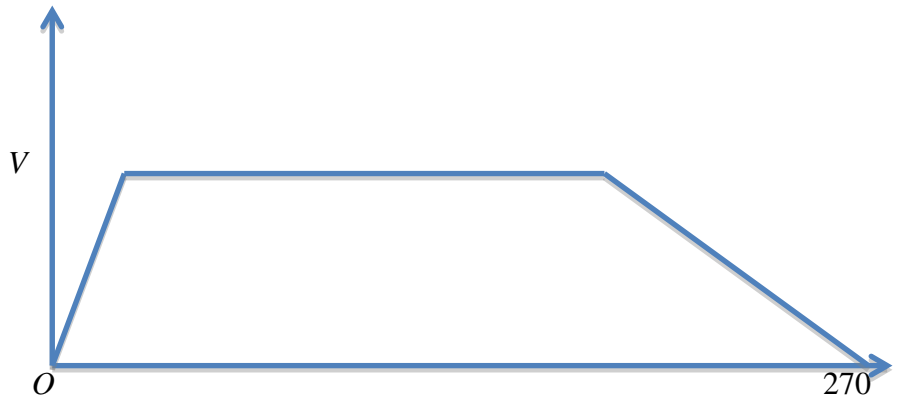
General Principles for Mechanics Marking

Question Number	Scheme	Marks
1	$T\cos 70^\circ + R = 40g$	M1A1
	$T\cos 20^\circ = F$	M1A1
	$F = \frac{3}{4}R$	B1
	Eliminate R and solve for T	**DM**1
	$T = 250$ N or 246 N	A1
		7
	Notes	
1	First M1 for resolving vertically with usual rules (must be using either 20^o or 70^o) First A1 for a correct equation Second M1 for resolving horizontally with usual rules (must be using either 20^o or 70^o) Second A1 for a correct equation B1 for $F = \frac{3}{4}R$ seen (could be on a diagram) Third DM1 dependent on previous two M marks Third A1 for either 250 (N) or 246 (N)	
2a	$M(D),\ (1080\times 1)-(400\times 2) = R_C \times 3.5$	M1 A1
	$R_C = 80$ (N)	A1
	$M(C),\ (1080\times 2.5)+(400\times 5.5) = R_D \times 3.5$	M1A1
	$R_D = 1400$ (N)	A1 (6)
	OR $(\uparrow)\ R_C + R_D = 1480$	M1A1
2b	$R_C + (R_C + 520) = 1480$ OR $R_D + (R_D - 520) = 1480$	M1 A1
	$M(D),\ (1080\times 1) - 400(x-4) = R_C \times 3.5$	M1 A1
	$x = 2.5$	A1 (5)
		11
	Notes	
2a	First M1 for a moments equation or a vertical resolution First A1 for a correct equation (R_C and/or R_D do NOT need to be substituted but if one is, it can be their value found from a previous equation)	

Question Number	Scheme	Marks
	Second A1 for $R_C = 80$ (N) Second M1 for a moments equation or a vertical resolution Third A1 for a correct equation (R_C and/or R_D do NOT need to be substituted but if one is, it can be their value found from a previous equation) Fourth A1 for $R_D = 1400$ (N) Enter marks for equations on ePEN, in the order they appear	
2b	First M1 for a moments equation or a vertical resolution First A1 for a correct equation (R_C and/or R_D do NOT need to be substituted but if one is, it can be their value found from a previous equation) Second M1 for a moments equation or a vertical resolution Second A1 for a correct equation (R_C and/or R_D do NOT need to be substituted but if one is, it can be their value found from a previous equation) Third A1 for $x = 2.5$ Enter marks for equations on ePEN, in the order they appear **N.B.** Equations may contain any or all of R_C , R_D or x for M marks but must contain only **one** of R_C or R_D to earn the A mark. **N.B.** If they assume that R_D = 520, they lose all the marks for part (b). **N.B** If they start with $2R$ = 1480 and then add or subtract (or both) 520 to their R value, M0**.** **N.B.** If brackets are omitted in a moments equation e.g. (520 + R_C).4 is written as 520 + R_C.4, the M mark can be scored	
3	$8mu - 4mu = 5mv$	M1A1
	$v = 0.8u$	A1
	For P: $-I = 4m(0.8u - 2u)$	M1 A1
	$I = 4.8mu$	A1
	OR For Q: $I = m(0.8u + 4u)$	M1 A1
	$I = 4.8mu$	A1
		6
	Notes	
3	First M1 for CLM with correct no. of terms, all dimensionally correct, to give an equation in m, u and their v only. Condone consistent g's or cancelled m's and sign errors. (N.B. The CLM equation could be obtained by equating the magnitudes of the impulses on each particle) First A1 for a correct equation (they may have - $5mv$) Second A1 for $0.8u$ or $-0.8u$ (as appropriate) Second M1 for using Impulse = Change in Momentum for either P or Q (M0 if *clearly* adding momenta or if g is included or if different mass in the two momentum terms) but condone sign errors.	

Question Number	Scheme	Marks
	Third A1 for $4m(0.8u-2u)$ or $-4m(0.8u-2u)$ **OR** for $m(0.8u+4u)$ or $-m(0.8u+4u)$ Fourth A1 for 4.8*mu* (must be positive since magnitude)	
4(i)	$\lvert\mathbf{F}_2\rvert^2 = 8^2+14^2-2\times 8\times 14\cos 30$	M1 A1
	Solve for $\lvert\mathbf{F}_2\rvert$= 8.1 (N) or better	M1 A1 (4)
	OR: $\lvert\mathbf{F}_2\rvert\cos\alpha = 14\cos 30 - 8$ $\lvert\mathbf{F}_2\rvert\sin\alpha = 14\sin 30$	M1 A1
	Solve for $\lvert\mathbf{F}_2\rvert$= 8.1 (N) or better	M1 A1 (4)
4(ii)	$\frac{\sin\theta}{8} = \frac{\sin 30}{8.12467}$ or $\frac{\sin\phi}{14} = \frac{\sin 30}{8.12467}$	M1 A1
	Solve: $\theta = 29.49^o$ or $\phi = 120.51^o$	M1 A1
	Bearing is 149° (nearest degree)	A1 (5)
	OR: $\lvert\mathbf{F}_2\rvert\cos\alpha = 14\cos 30 - 8 = 4.124(355.)$ $\lvert\mathbf{F}_2\rvert\sin\alpha = 14\sin 30$	M1 A1
	Solve: $\alpha = 59.49^o$	M1 A1
	Bearing is 149° (nearest degree)	A1 (5)
	Notes	
4(i)	First M1 for use of cos rule with 30° First A1 for a correct equation **OR:** First M1 for 'resolving' in 2 directions with 30° / 60° (**N.B.** M0 here if cos/sin confused) First A1 for TWO correct equations Second M1 for solving for $\lvert\mathbf{F}_2\rvert$, independent *but* must be solving a 'correct cosine formula but with wrong angle' if using method 1 **OR** for eliminating α from two equations, independent *but* equations must have the correct structure if using method 2 Second A1 for 8.1 (N) or better	
4(ii)	First M1 for use of sin rule with 30° First A1 for a correct equation (allow 8.12 or better) **OR:** First M1 for 'resolving' in 2 directions with 30° / 60°	

Question Number	Scheme	Marks
	First A1 for TWO correct equations (allow 4.12 or better) Second M1, independent, for solving a 'correct sine formula' for θ or ϕ **OR** independent for solving two equations, with correct structure, for α Second A1 for $\theta =$ AWRT 29^o or $\phi =$ AWRT 121^o **OR** $\alpha =$ AWRT 59^o	
	Third A1 for Bearing is 149^o (nearest degree)	
	N.B. First M1A1 Could use cos rule to find an angle	
	N.B. If the resolving method is used and there are no (i) or (ii) labels, only award M1A1 in both cases when an answer is reached.	
5a	$0 = 14.7^2 - 2 \times 9.8h$	M1A1
	$h = 11.025$	A1
	max ht $= 13.5$ or 14 (m)	A1 (4)
5b	$-1.5 = 14.7t - 4.9t^2$	M1A1
	$4.9t^2 - 14.7t - 1.5 = 0$	
	$t = \dfrac{14.7 \pm \sqrt{14.7^2 + 6 \times 4.9}}{9.8}$	**DM**1
	$t = 3.1$ or 3.10 (s)	A1 (4)
5c	$v^2 = 14.7^2 + 2 \times (-9.8) \times (-2.5)$	M1 A1
	$v = 16.3$ or 16 (m s^{-1})	A1 (3)
		11
	Notes	
5a	**N.B.** If they use $g = 9.81$, lose first A mark (once for whole question) but all other A marks can be scored. First M1 for a complete method to find the height (Could involve two *suvat* equations) condone sign errors. First A1 for a correct equation (or equations) Second A1 for $h = 11$ (may be unsimplified) or better (For other methods, give this A1 for any correct (may be unsimplified) intermediate answer) Third A1 for 13.5 or 14 (m)	
5b	First M1 for a complete method to find the required time (they may find the time up (1.5 s) and then add on the time down. Condone sign errors First A1 for a correct equation or equations Second DM1, dependent, for solving to find required time Second A1 for 3.1 or 3.10 (s)	

Question Number	Scheme	Marks
5c	First M1 for a complete method to find the speed / velocity(Could involve two *suvat* equations) Condone sign errors but must have correct numbers in their equation(s) First A1 for a correct equation (or equations) Second A1 for 16 or 16.3 (m s^{-1}) Must be *positive (speed)*	
6a		B1 shape B1 270, *V* (2)
6b	$\frac{V}{0.6}=\frac{5V}{3}$ **Given answer**	M1A1 (2)
6c	Time decelerating is $5V$	B1
	$\frac{1}{2}V\frac{5V}{3}+(270-5V-\frac{5V}{3})V+\frac{1}{2}V.5V=1500$ **OR:** $\frac{1}{2}(270+270-5V-\frac{5V}{3})V=1500$	M1 A2
	$V^2-81V+450=0$ **Given answer**	**DM1**A1 (6)
6d	$V^2-81V+450=0$ $(V-6)(V-75)=0$ or $V=\frac{81\pm\sqrt{81^2-4\times450}}{2}$	M1 solving
	$V=6$ or 75	A1 A1
	$V=6$ since $(5\times75)>270$ or $V=75$ unrealistic	**B**1 (4)
		14
	Notes	
6a	First B1 for a trapezium with line starting at the origin Second B1 for 270 and *V* correctly marked	
6b	M1 for $(t=)\frac{V}{0.6}$; **N.B.** M1A0 for $V=0.6t$ then answer Must see division or intermediate step from $V=0.6t$ e.g. Changing 0.6 into 3/5. A1 for $t=\frac{5V}{3}$ **Given answer**	

Question Number	Scheme	Marks
6c	B1 for $5V$ identified appropriately First M1 for clear attempt to equate the *total* area under graph to 1500. (Must include all 3 parts (if not using the trapezium rule) with $\frac{1}{2}$ seen at least once to give equation in V only; may use (1 triangle + 1 trapezium) or (rectangle - trapezium) (May use *suvat* for one or more parts of the area) A2 for a correct equation, -1 e.e.o.o. Second **DM**1 dependent on first M1 for multiplying out and collecting terms and putting into appropriate form Third A1 for correct equation. **Given answer**	
6d	First M1 for solving their 3 term quadratic equation for V N.B. This M1 can be implied by two correct roots but if either answer incorrect then an explicit method must be shown for this M mark. First A1 for $V = 6$ Second A1 for $V = 75$ B1 on ePEN but treat as **DM**1, dependent on both previous A marks, for either reason	
7a	$T - 3mg\sin\alpha - F = 3ma$	M1A1
	$4mg - T = 4ma$	M1A1 (4)
7b	$F = \frac{1}{4}R;\ R = 3mg\cos\alpha$	B1; M1A1
	$T - 2.4mg = 3ma$ $4mg - T = 4ma$	M1
	$a = \frac{8g}{35}$ **Given answer**	A1 (5)
7c	Particles have same acceleration	B1 (1)
7d	$v^2 = 2 \times \frac{8g}{35} \times 1.75$ $(= 0.8g)$	M1 A1
	$-3mg\sin\alpha - F = 3ma'$	M1
	$a' = -0.8g$	A1
	$0 = 0.8g + 2 \times (-0.8g)s$	M1 A1
	Total distance = 0.5 + 1.75 = 2.25 (m) Accept 2.3 (m)	A1 (7)
		17
	Notes	
7a	First M1 for equation of motion for A with usual rules First A1 for a correct equation Second M1 for equation of motion for B with usual rules Second A1 for a correct equation **N.B.** If using different tension in second equation, M0 for that equation	

Question Number	Scheme	Marks
7b	B1 for $F = \frac{1}{4}R$ seen e.g. on diagram First M1 for resolving for *A* perp to the plane First A1 for correct equation N.B. These first 3 marks can be earned in (a). Second M1 (Hence) for substituting for *R* and *F* and trig. and solving for *a* (must be some evidence of this) their equations of motion from part (a) Second A1 for **given answer (Not available if not using exact values for trig ratios)**	
7c	B1 for particles have same acceleration (B0 for same velocity or if incorrect extras given)	
7d	First M1 for attempt to find speed (or speed^2) when *B* hits the ground (M0 if uses *g*) First A1 for a correct expression Second M1 for attempt to find deceleration of *A* Second A1 for correct deceleration Third M1 for using deceleration (must have found a deceleration) with $v = 0$ to find distance (M0 if uses *g*) Third A1 for a correct equation Fourth A1 for 2.25 (m)	