Pearson

Mark Scheme (Results)

Summer 2017

Pearson Edexcel International A Level
In Mechanics (WME01) Paper 1

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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.
- If a candidate quotes a formula correctly but makes a slip in applying it then the associated M1 is scored. However, an incorrect substitution with no formula quoted is M0.
- 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)

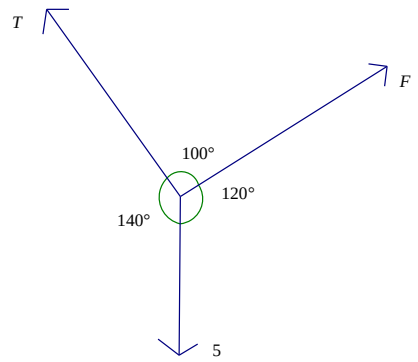
  HL Hooke's Law

  SHM Simple harmonic motion

  PCLM Principle of conservation of linear momentum

  RHS, LHS Right hand side, left hand side.

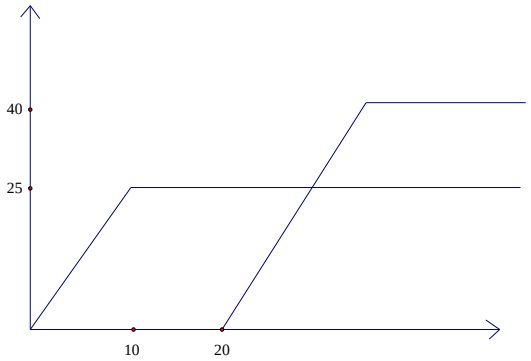
June 2017 Standardisation
WME01 Mechanics M1
Mark Scheme

Question	Scheme	Marks	Notes
1.	Vertically: $T\cos 40 + F\cos 60 = 5$	M1	First equation seen for resolution of forces. No missing/additional terms Condone sin/cos confusion and sign error(s) 5*g* in place of 5 is an accuracy error *T* must link with 40 or 50 and *F* with 60 or 30
		A1	Correct equation
	Horizontally: $T\cos 50 = F\cos 30$	M1	Second equation seen for resolution of forces No missing/additional terms Condone sin/cos confusion and sign error(s) 5*g* in place of 5 is an accuracy error *T* must link with 40 or 50 and *F* with 60 or 30
		A1	Correct equation
	Perpendicular to line of *F*: $T\cos 10 = 5\cos 30$		
	Perpendicular to line of *T*: $F\cos 10 = 5\cos 50$		
	Solve for T or F	dM1	Dependent on using equation(s) that scored M mark(s)
	$T = 4.3969..$ N = 4.4 N (or better)	A1	One correct
	$F = 3.263....$ = 3.3 N(or better)	A1	Both correct
		[7]	
1 alt			Solution using Lami's theorem Or a triangle of forces
	$\frac{5}{\sin 100} = \frac{F}{\sin 140} = \frac{T}{\sin 120}$	M1	One pair including $\frac{5}{\sin 100}$ or $\frac{5}{\sin 80}$ Incorrect pairing of forces and angles is M0
		A1	Two fractions correct
		M1	Second pair of fractions
		A1	All correct
	Solve for T or F	dM1	Dependent on using equation(s) that scored M mark(s)
	$T = 4.3969..$ N = 4.4 N (or better)	A1	One correct
	$F = 3.263....$ = 3.3 N(or better)	A1	Both correct

Question	Scheme	Marks	Notes
2.(a)	M(C) $140(a-2)+30(2a-2)=120$ x 4 M(G) $50(a-2)+30a=120(6-a)$ M(D) $4\times50+30(2a-6)=140(6-a)$ M(B) $140a=120(a-6)+50(2a-2)$ M(A) $50\times2+120\times6=140a+30\times2a$	M1	Moments or alternative complete method to form an equation in a only. Dimensionally correct. Condone sign error(s) No missing/additional terms Condone a common factor of g
		A1	At most one error
	$(200a=820)$	A1	Correct unsimplified equation in a
	$a=4.1$	A1	
		(4)	
(b)	$(\uparrow),\ (2R=170 \Rightarrow) R=85$	B1	Or a correct second moments equation in their a to achieve 2 equations in 2 unknowns
	M(A) $85\times2+85\times x = 140\times a+30\times2a$ M(C) $85(x-2)=140\times(a-2)+(2a-2)\times30$ M(G) $85\times(a-2)+30\times a=85(x-a)$ M(E) $30(2a-x)+85(x-2)=140(x-a)$ M(B) $85\times(2a-2)+85(2a-x)=140\times a$	M1	Moments equation with equal reactions in a or their a. Dimensionally correct. No missing/additional terms. Condone sign error(s) Accept alternative complete method to form an equation in a different horizontal distance to E Condone incorrect R, $R\neq120, R\neq50$ Condone a common factor of g
		A1ft	At most one error Follow their a and their $R\neq120, R\neq50$
		A1ft	Correct unsimplified equation in AE Follow their a and their $R\neq120, R\neq50$
	$AE=\frac{130}{17}$ m (7.6 m or better)	A1	
			If they find a different x, e.g. $CE=5.6$ and go no further, they score 4/5.
		(5)	
		[9]	
			A candidate who has a common factor of g throughout can score 8/9

Question	Scheme	Marks	Notes
3.(a)	$4.2 = 0.5(v - -4)$	M1	Impulse/ momentum equation Must be using $I = \pm(mv - mu)$ Inclusion of g is M0
		A1	Correct unsimplified equation
	$v = 4.4 \text{ ms}^{-1}$	A1	Must be positive - the question asks for the speed.
		(3)	
(b)	$2 - 2m = -\frac{1}{2}v \pm m$	M1	Conservation of momentum. No missing/additional terms. Condone sign errors. Dimensionally correct. Follow their v Condone a common factor of g throughout
		A1ft	Correct equation for one solution. Follow their v
		A1ft	Correct unsimplified equation(s) for both possible solutions. Follow their v
	$m = 1.4$ or 4.2	A1	Need both
		OR	
	$4.2 = m(\pm 1 - -2)$	M1	Impulse on Q. Dimensionally correct. Condone sign errors
		A1	Correct equation for one solution
		A1	Correct unsimplified equation for both possible solutions
	$m = 1.4$ or 4.2	A1	Need both
		(4)	
		[7]	

Question	Scheme	Marks	Notes
4(a)	$I = 0.2(7--10)$	M1	Impulse momentum equation. Dimensionally correct. Must be using $\pm(mv-mu)$
	$= 3.4$ N s	A1	
		(2)	
(b)	$0 = 7^2 - 2gH$	M1	Complete method to find max ht Must be using 7 ($u = 10$ is M0)
	$H = 2.5$ m	A1	Must be positive
		(2)	
(c)	$1 = 7t - 4.9t^2$	M1	Complete method to form an equation in t (using 7)
	$4.9t^2 - 7t + 1 = 0$	A1	Or equivalent
	$t = \dfrac{7 \pm \sqrt{49 - 19.6}}{9.8}$	dM1	Solve for t (sight of either root $\Rightarrow$ M1) Dependent on previous M1
	$= 0.16$ s or 0.161 s	A1	Final answer (do not ISW) Max 3 s.f.
		(4)	
(c) alt	$v^2 = 49 - 2g$	M1	Find speed when 1 m up and use of *suvat* to find t
	$v = \sqrt{\dfrac{147}{5}} = 7 - gt$	A1	or equivalent
		dM1	Solve for t Dependent on previous M1
	$t = 0.16$ s or 0.161 s	A1	Final answer (do not ISW) Max 3 s.f.
		(4)	
		[8]	

Question	Scheme	Marks	Notes
5. (a)		B1 B1 B1	One graph correct shape Both graphs correct shape, on same sketch and intersecting (with different start times) Figs 10,20,25,40 shown (with 20 as the second start time) Ignore all vertical lines
		(3)	
(b)	20 + 10	M1	Complete method
	= 30	A1	
		(2)	
(c)	$\frac{40}{t_1 - 20} = \frac{25}{10}$	M1	Complete method to find time when Q reaches 40 m s^{-1}
		A1	Correct unsimplified equation
	$\Rightarrow t_1 = 36$	A1	
Or:	Time to reach 40 m s^{-1} is $\frac{40}{2.5}(=16)$ (M1A1)		
	Time from start $= \frac{40}{2.5} + 20 = 36$ (A1)		(seen or implied)
		M1	Find distance travelled by either train at $t = T$
	$\frac{(T + T - 10)}{2} \times 25$	A1	One correct
	$\frac{(T - 20 + T - 36)}{2} \times 40$	A1ft	Both correct. Follow their 36
	Equate and solve for T	dM1	
	$T = 66\frac{1}{3}$	A1	Accept 66 or better
		(8)	
		13	

Question	Scheme	Marks	Notes
6. (a)	$\mathbf{v} = (10\mathbf{i} + 4\mathbf{j}) + 6(-2\mathbf{i} + 3\mathbf{j})$	M1	Use of $\mathbf{v} = \mathbf{u} + \mathbf{a}t$ with $t = 6$
	$= -2\mathbf{i} + 22\mathbf{j}$	A1	
	$\tan\theta = \pm\frac{22}{2}$ or $\tan\theta = \pm\frac{2}{22}$	M1	Correct use of trig to find a relevant angle for their **v**
	$\theta = 85^\circ$ or $5°$	A1	Seen or implied
	bearing is 355°	A1	
		(5)	
(b)	$\mathbf{v} = (10\mathbf{i} + 4\mathbf{j}) + t(-2\mathbf{i} + 3\mathbf{j})$	M1	Use of $\mathbf{v} = \mathbf{u} + \mathbf{a}t$
	$\left(= (10 - 2t)\mathbf{i} + (4 + 3t)\mathbf{j}\right)$	A1	Correct unsimplified
	$(10 - 2t) = (4 + 3t)$	DM1	Equate coefficients to give equation in t only
	$t = 1.2$	A1	
		(4)	
		[9]	

Question	Scheme	Marks	Notes
7(a)	$\lvert\mathbf{R}\rvert^2 = 8^2 + 5^2 - 2 \times 8 \times 5\cos 130^o$	M1	Use of cosine rule
		A1	At most one error e.g. 50 in place of 130
		A1	Correct unsimplified.
	$\lvert\mathbf{R}\rvert = 11.9$ N (3 SF)	A1	12 or better
		(4)	
7a alt	$\lvert\mathbf{R}\rvert^2 = (5+8\cos 50°)^2 + (8\sin 50°)^2$	M1	Use of Pythagoras (with usual rules for resolved components)
	$(= 10.14^2 + 6.13^2)$	A1	At most one error
		A1	Correct unsimplified.
	$\lvert\mathbf{R}\rvert = 11.9$ N (3 SF)	A1	
		(4)	
(b)	$\frac{\sin\theta}{5} = \frac{\sin 130}{11.85}$	M1	Independent M1. Use of sine rule or cosine rule with their $\lvert\mathbf{R}\rvert$
		A1ft	Follow their $\lvert\mathbf{R}\rvert$
	$\sin\theta = \frac{\sin 130}{11.85}$	DM1	Solve for θ
	$\theta = 19^o$	A1	
		(4)	
7balt	$\tan\alpha = \frac{8\sin 50°}{5+8\cos 50°}$	M1	Independent M1 Correct use of trig to find direction of **R** Or use cosine rule to find α
	$(\alpha = 31.1...°)$	A1ft	Correct unsimplified. Follow their components
	$\theta = 50° - \alpha$	DM1	Use their α to solve for θ
	$\theta = 19^o$	A1	
			Alternatively, find $\beta = 58.8....$ and use $\theta = \beta - 40$
		(4)	
		[8]	

Question	Scheme	Marks	Notes
8. (a)			
	$R = mg$	B1	Resolve vertically at Q
	$F = \frac{1}{2}R$	B1	Use of $F = \mu R$
	$T - F = ma$	M1	Equation of motion for Q No missing/additional terms Condone sign error(s)
		A1	
	$2mg\sin\alpha - T = 2ma$	M1	Equation of motion for P No missing/additional terms Condone sign error(s) and sin/cos confusion
		A1	
(i)		dM1	Solve for a or T Dependent on 2 correct equations (one of which could be for the whole system)
	$a = \frac{7g}{30} = 2.3$ or $2.29\ \text{ms}^{-2}$	A1	a or T correct
(ii)	$T = \frac{7mg}{30} + \frac{mg}{2}$	dM1	Solve for second unknown Dependent on 2 correct equations (one of which could be for the whole system)
	$= \frac{11mg}{15}$	A1 (10)	Both correct Accept $T = 7.2m$ or better
(b)	$a = 0 \Rightarrow 2mg\sin\alpha - T = 0$	M1	Use equation of motion of P to find T.
	$\Rightarrow T = \frac{6mg}{5}$	A1	$(11.76m)$
	$\mu mg \geq \frac{6mg}{5}$	dM1	For Q, $T \leq \mu R$. Dependent on preceding M Condone use of $T = \mu R$
	Least value is 1.2	A1 (4)	
(b) alt	$2mg\sin\alpha - \mu R = 0$	M1A1	Using the combined equation
	$\frac{6}{5}mg = \mu mg$	M1	Substitute for trig and R and solve
	Least value is 1.2	A1 (4)	
		[14]	

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