Mark Scheme (Results)

Summer 2014

Pearson Edexcel International A Level in Mechanics 1 (WME01/01)

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Summer 2014
Publications Code IA039515

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:

<u>‘M’ marks</u>
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.

<u>‘A’ marks</u>
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.

<u>‘B’ marks</u>
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 $\sqrt{}$ 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. 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.

6. 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

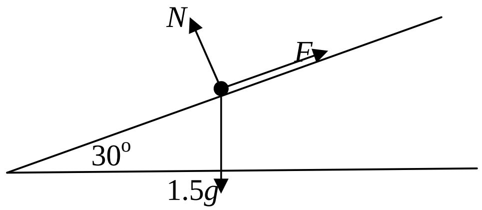
  SHM Simple harmonic motion

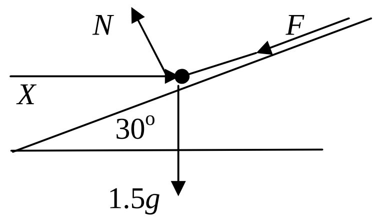
  PCLM Principle of conservation of linear momentum

  RHS, LHS Right hand side, left hand side.

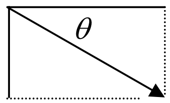
Question Number	Scheme	Marks	Notes
1.			
(a)	$0.9\times 2-0.6v=0+0.6\times 2$	M1	Equation with all the terms – condone "0" missing. Terms must be of the form *mv*, but condone sign errors. Condone *g* present as a common factor.
		A1	Correct unsimplified equation
	$v=1$	A1 (3)	
(b)	$I=0.6(v+2)=1.8\text{ N s}$ or $I=0.9\times 2=1.8\text{ N s}$	M1	Change in momentum of *A* or of *B*. Condone sign slips and negative answer. No *g*.
		A1	1.8 only (or exact equivalent) From correct work only.
		(2)	
		[5]	
	Watch out for fortuitous answers in (b); $v=5$ from (a) used in (b) will score at most M1A0 in (b)		

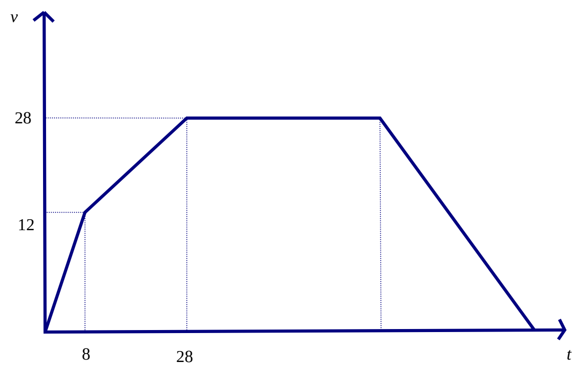
Question Number	Scheme	Marks	Notes
2 (a)	$h = -20\times 5 + \frac{1}{2}\times 9.8\times 25$	M1	Use of $s = ut + \frac{1}{2}at^2$ to find *h*. Must quote the correct formula and be using 20 & 5, but condone slips in substitution. Accept complete alternative solutions working via the maximum height. (max ht 20.4..., time to top 2.04...) Accept complete alternative methods using other *suvat* equations.
		A1	Correctly substituted equation(s) Condone use of a premature approximation.
	$h = 22.5$	A1 (3)	Final answer. Accept 22.5 or 23. Maximum 3sf. -22.5 is A0.
	NB Do not ignore subsequent working if they reach 22.5 and then move on to do further work.		
(b)	$V^2 = 20^2 + 2\times 9.8\times 22.5$ OR $V = -20 + (5\times 9.8)$	M1	First ball - use of *suvat* to find V or V^2 Follow their *h*.
	$(V^2 = 841)$ $= 29$	A1	Correct only (condone -29)
	$\left(\frac{3}{4}V\right)^2 = w^2 + 2\times 9.8\times 22.5$	M1	Second ball - *suvat* equation in V (or their V) to find *w*. Must be using the $\frac{3}{4}$.
	$w^2 = \frac{9}{16}\times 841 - 2\times 9.8\times 22.5$	A1ft	Correctly substituted equation with their V and their *h*.
	$w = 5.66$	A1	or 5.7. Answer correct to 2 s.f. or to 3 s.f.
		(5)	
		[8]	

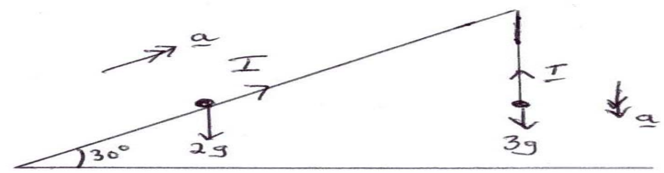
Question Number	Scheme	Marks	Notes
3			
(a)	For equilibrium	M1	For resolution of forces parallel or perpendicular to the plane. Weight must be resolved. Condone sin/cos confusion.
	$\text{R}(\perp \text{ plane})\ N = 1.5g\cos 30$	A1	Correct equation for N (12.7)
	$\text{R}(\parallel \text{ plane})\ F = 1.5g\cos 60$	A1	Correct equation for F (7.35). Condone μR
	$\frac{F}{N} = \frac{\cos 60}{\cos 30} = 0.577... < 0.6$	M1	Use of $F_{\text{max}} = \mu N$ and compare with F, or find the value of their $\frac{F}{N}$ and compare with μ
	$\therefore$ equilibrium	A1 (5)	Reach **given conclusion** correctly. They must make some comment, however brief.
	ALT for first 3 marks:		
	Resolve vertically $N\cos 30 + F\cos 60 = 1.5g$	M1A1	
	Resolve horizontally $N\cos 60 = F\cos 30$	A1	
	ALT for last 2 marks:		
	$F_{\text{max}} = 0.6 \times 12.73 = 7.63 > 7.35$	M1	
	$\therefore$ P is at rest	A1	
	Candidates who think that the diagram applies to (a) will score nothing in (a) but if they carry their results forward in to (b) then their work can score the marks available in (b).		If the candidate has given the equation of motion for the particle moving down the plane then A1 for $1.5g\sin 30 - \mu R = \pm 1.5a$ To score more they need to comment correctly on their answer: a = -0.19 impossible M1 Conclude that the particle cannot be moving. A1

Question Number	Scheme	Marks	Notes
(b)			
	R$\left(\perp\ \text{plane}\right)$ $N = 1.5g\cos 30 + X\cos 60$	M1	Requires all 3 terms. Condone sin/cos confusion and sign errors.
	R$\left(\parallel\ \text{plane}\right)$ $X\cos 30 = 1.5g\cos 60 + F$	M1	Requires all 3 terms. Condone sin/cos confusion and sign errors.
		A1	Both equations correct unsimplified.
	$N = 1.5g\cos 30 + \dfrac{\cos 60}{\cos 30}\left(1.5g\cos 60 + 0.6N\right)$ $N\left(1 - \dfrac{\cos 60}{\cos 30}\times 0.6\right) = 1.5g\cos 30 + \dfrac{\cos 60}{\cos 30}\times 1.5g\cos 60$	DM1	Use $F = 0.6N$ to form an equation in N or in X. Dependent on the two previous M marks OR: $0.6(X\cos 60 + 1.5g\cos 30) + 1.5g\sin 30 = X\cos 30$
	(i) $N = 26$ or 26.0 (N)	A1	First value found correctly. (N or X)
	(ii) $X = \left(N - 1.5g\cos 30\right) \div \cos 60$	DM1	Substitute their N (or X) to find X (or N) Dependent on the previous M mark.
	$X = 26$ or 26.5	A1 (7) **[12]**	Second value found correctly.
Alt:	$N\cos 30 - F\cos 60 = 1.5g,\quad N\cos 30 - 0.6N\cos 60 = 1.5g$	M1, DM1 A1	Resolve vertically. Condone sin/cos confusion. Must have all terms. Use $F = 0.6N$ Correct unsimplified equation
	$N = \dfrac{1.5g}{\cos 30 - 0.6\cos 60} = 26$ or 26.0	A1	
	$X = F\cos 30 + N\cos 60, = N\left(0.6\cos 30 + \cos 60\right)$	M1, DM1	Resolve horizontally. Follow their N. Must have all terms. Condone sin/cos confusion. Substitute for F and N
	$X = 26$ or 26.5	A1	

Question Number	Scheme	Marks	Notes
4 (a)	(i) $\mathrm{M}(D)$ $3R_C + 1\times 3g = 2\times 4g + 5\times 2g$	M1	e.g.Take moments about D – requires all 4 terms of the correct form, but condone sign errors. 1x need not be seen
		A1	Correct unsimplified equation
	$R_C = 5g$ or $49\,\mathrm{N}$	A1	
	(ii) $\mathrm{R}(\uparrow)$ $R_C + R_D = 4g + 2g + 3g$	M1	e.g.Resolve vertically to form an equation in R_C and R_D, requires all 5 terms
		A1	Correct unsimplified equation
	$R_D = 4g$ or 39 or 39.2N	A1 (6)	
Alt	M(A) $3\times 4g + 6\times 3g = 2R_C + 5R_D\ (= 30g)$	M1A1	Two equations – M1A1 for each
	M(B) $3\times 4g + 6\times 2g = R_D + 4R_C\ (= 24g)$	M1A1	
	$\mathrm{M}(C)$ $3R_D + 2\times 2g = 1\times 4g + 4\times 3g$		
	M(centre) $3g\times 3 + R_C = 2R_D + 2g\times 3$		
	$R_C = 5g$ or $49\,\mathrm{N}$, $R_D = 4g$ or 39 or 39.2N	A1,A1	Solve simultaneously for R_C and R_D
(b)	$\mathrm{M}(D)$ $3R_C + xg = 8g + 10g$ $(3R_C = (18 - x)g)$	M1	First equation in x and R (or R_C and R_D) – correct terms required but condone sign slips.
	$\mathrm{R}(\uparrow)$ $R_C + R_D = 4g + 2g + xg$	M1	A second equation, correct terms required but condone sign slips.
	Alternatives: $\mathrm{M}(B)$ $4R_C + R_D = 12g + 12g$		
	$\mathrm{M}(A): 2R_C + 5R_D = 6xg + 3\times 4g$		
	$\mathrm{M}(C): 2\times 2g + 3R_D = 4xg + 1\times 4g$		
	$2(18 - x)g = 3(6 + x)g$	DM1	Use $R_C = R_D$ and solve for x. (as far as x =…..) Dependent on the two previous M marks.
	$x = 3.6$	A1 (4) **[10]**	

Question Number	Scheme	Marks	Notes
5 (a)	Speed = $\sqrt{3^2+(-2)^2}$ or $\sqrt{3^2+2^2}$ $=\sqrt{13}\text{ m s}^{-1}$	M1 A1(2)	Use Pythagoras Accept 3.6 or better
(b)			Ignore their diagram if it does not support their working
	$\tan\theta=\dfrac{2}{3}$, $\theta=33.7$ OR $\tan\theta=\dfrac{3}{2}$, $\theta=56.3$	M1	Find a relevant angle
		A1	Their angle correct (seen or implied)
	OR find another useful angle		
	Bearing = 124	A1 (3)	Correct bearing. Accept 124^{o} or awrt 124/124^{o} Accept N 124 E or S 56 E
(c)	$\mathbf{r}_B=10\mathbf{j}+t(3\mathbf{i}-2\mathbf{j})$	M1 A1	Find the position vector of *B* or *G* at time *t* Correct for *B*
	$\mathbf{r}_G=4\mathbf{i}-2\mathbf{j}+t\left(\dfrac{5}{3}\mathbf{i}+2\mathbf{j}\right)$	A1	Correct for *G*
	$3t=4+\dfrac{5}{3}t$ OR $10-2t=-2+2t$	DM1	Compare coefficients of **i** or of **j** to form an equation in *t*.
	(i) $t=3$ s	A1	Correct unambiguous conclusion.
	(ii) $\mathbf{r}=10\mathbf{j}+3(3\mathbf{i}-2\mathbf{j})=(9\mathbf{i}+4\mathbf{j})$ m OR $\mathbf{r}=4\mathbf{i}-2\mathbf{j}+3\left(\dfrac{5}{3}\mathbf{i}+2\mathbf{j}\right)=(9\mathbf{i}+4\mathbf{j})$ m	A1 (6)	Final answer. Accept with no units. Do not ignore subsequent working.
		[11]	

Question Number	Scheme	Marks	Notes
6(a)	$v_1 = 8\times 1.5\ (=12)$	M1	Use of $v=u+at$ or equivalent for $t=8$
	$v_2 = 12+0.8\times 20$	M1	Follow their 12
	$v_2 = 28\ \text{m s}^{-1}$	A1 (3)	
(b)		B1	shape
		B1ft	nos: 8,28; 12,28 indicated. Follow their 12, 28
		(2)	
(c)	first 8 s: dist = $\frac{1}{2}\times 8\times 12\ \ (=48)$	M1	Correct method for distance for the triangle (0-8) or the trapezium (8-28)
		A1ft	Follow their 12
	next 20 s: dist = $\frac{1}{2}\times(12+28)\times 20\ \ (=400)$	A1ft	Follow their 12, 28
	Total dist = 448 m	A1 (4)	Correct answer only (cao)
(d)	$0=28^2-2\times 2.8s$	M1	Find area of right hand triangle or an expression in *T* for the trapezium (rectangle + triangle).
	$s=\frac{28^2}{2\times 2.8}\ (=140)$	A1ft	Follow their 28
	$448+140+28T=2000$	DM1	Form an equation in T for their 16, 448 and 140
	$T=\frac{2000-448-140}{28}=50.4$	A1 (4)	Or better (50.42857...) Accept 50.
		[13]	

Question Number	Scheme	Marks	Notes
7			
(a)	$3g - T = 3a$	M1	Eqn of motion for Q: must have the correct terms but condone sign errors
		A1	Correct equation
	$T - 2g\cos 60 = 2a \qquad (\ T - g = 2a\ )$	M1	Eqn of motion for P: must have the correct terms but condone sign errors. Weight must be resolved.
		A1	Correct equation
	Allow M1A1 for $3g - 2g\cos 60 = 5a$ in place of either of these two equations		
	$2g = 5a \qquad a = \dfrac{2g}{5}$ *	DM1	Use an exact method to solve for a (i.e. not the equation solver on their calculator). Dependent on the first 2 M marks or the M for the combined equation.
		A1	Given answer derived correctly from exact working.
	$T = 2\times\dfrac{2g}{5} + g = \dfrac{9g}{5}$	M1	Use given acceleration to solve for T.
		A1 (8)	accept 18 or 17.6
(b)	$v^2 = 2\times\dfrac{2g}{5}\times 0.6 = \dfrac{2.4g}{5}$	M1	Use the given acceleration to find the speed
	$v = \dfrac{2}{5}\sqrt{3g}$ oe involving g	A1 (2)	Accept 2.2 or 2.17

Question Number	Scheme	Marks	Notes
(c)	String slack: accel of P (up plane) = $-g\cos 60 = -\frac{1}{2}g$	B1	
	$0 = \frac{2.4g}{5} - gs$	M1	Use of $v^2 = u^2 + 2as$ or equivalent for their acceleration $\neq \frac{2g}{5}$
	$s = \frac{2.4g}{5} \times \frac{1}{g} = \frac{2.4}{5} = 0.48$	A1	
	Total dist = 1.08 m	A1ft (4)	0.6 + their 0.48
(d)	$0 = \frac{2}{5}\sqrt{3g} - \frac{g}{2}t \qquad (0 = 2.17 - 4.9t)$	M1	Use of $v = u + at$ or equivalent with their acceleration $\neq \frac{2g}{5}$ to find t.
	$t = \frac{4\sqrt{3g}}{5g} = 0.4426\ldots$		
	$= 0.44$ or 0.443	A1 (2)	only
		[16]	

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