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Mark Scheme (Results)

January 2015

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.
- 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. 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.
- 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.

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6677 Mechanics M1
Mark Scheme

Question Number	Scheme	Marks
1.(a)	$8mu - 3mu = 5mv$	M1 A1
	$v = u$	A1 (3)
(b)	Original direction of motion of B o.e.	B1 (1)
(c)	For A: $I = m(u - -3u)$ **OR** For B: $I = 4m(-u - -2u)$	M1 A1
	$= 4mu$ $= 4mu$	A1 (3)
		7

NOTES

Question 1(a)

M1 for attempt at CLM equation, with correct no. of terms, dimensionally correct. Allow consistent extra g's and cancelled *m*'s and sign errors.

(M1 if they find the impulse on each particle *and eliminate* the impulse to give an equation – then use above criteria for their equation)

First A1 for a correct equation. ($3mu - 8mu = 5mv$ or $-5mv$ oe)

Second A1 for u ($-u$ A0)

N.B. Allow *u*'s to be dropped or omitted in the equation if u is inserted in answer at the end. (Full marks can be scored). However, if u is not inserted then M0.

Question 1(b)

B1 for (original) direction of B or opposite to original direction (of A) oe. (B0 for 'left' or direction changed).

N.B. Must follow from $v = u$ or $-u$ obtained in (a).

Question 1(c)

M1 for attempt at impulse = difference in momenta, for either particle, (must be considering *one* particle) (M0 if g's are included or if *m* omitted or if mass doesn't match velocities used)

A1 for $\pm m(-u - 3u)$ or $\pm 4m(-u - (-2u))$

A1 for $4mu$ cao ($-4mu$ is A0) Allow change of sign at end to obtain magnitude.

2. (a)	$T\sin\alpha + 65.8 = 50g\sin\alpha$ $T = 255$ N or 260 N	M1 A1 **DM**1A1 (4)
(b)	$65.8\cos\alpha = R\sin\alpha$ $\mu = 65.8/R = \tan\alpha = 7/24,$ 0.29 or better	M1 A1 M1 A1 (4) **8**

NOTES

Question 2(a)
First M1 for resolving parallel to the plane (or an equation in *T* only)
First A1 for a correct equation.
Second M1 dependent for producing a value for *T*.
Second A1 for 255 (N) or 260 (N).

Question 2(b)
First M1for **any** equation containing *R*.
First A1 for a correct equation. (If equation includes a *T* term, they must be using a correct value of *T* to score this mark)
Second M1 for (65.8/their *R*).
Second A1 for 7/24, 0.29 or better.

3.(a)	$\tan\alpha = 1/3 \quad \Rightarrow \quad \alpha = 18.4^{o}$	M1 A1
	Bearing is 288° (nearest degree)	A1 (3)
(b)	$\mathbf{r} = (21\mathbf{i} + 5\mathbf{j}) + t(-6\mathbf{i} + 2\mathbf{j})$	B1 (1)
(c)	$21 - 6t = -(5 + 2t)$	M1 A1
	$t = 6.5$	A1 (3)
		7

NOTES

Question 3(a)

First M1 for $\arctan(\frac{\pm 2}{\pm 6})$

First A1 for a correct value from their expression, usually 18.4^{o} or 71.6^{o}

Second A1 for 288 (nearest degree)

Question 3(b)

B1 for $(21\mathbf{i} + 5\mathbf{j}) + t(-6\mathbf{i} + 2\mathbf{j})$

Question 3(c)

M1 for equating the negative of their **i**-component to their **j**-component oe

Allow equating the components for the M mark.

First A1 for a correct equation.

Second A1 for $t = 6.5$

4.	$h = \frac{1}{2}gt^2$	B1
	$h = 7.35(t - \frac{1}{2}) + \frac{1}{2}g(t - \frac{1}{2})^2$	M1 A1
	$\frac{1}{2}gt^2 = 7.35(t - \frac{1}{2}) + \frac{1}{2}g(t - \frac{1}{2})^2$	**DM**1
	$t = 1$	M1 A1
	h = 4.9	A1 **7**

NOTES

Question 4

B1 for $h = \frac{1}{2}gt^2$ or $h = \frac{1}{2}g(t + \frac{1}{2})^2$

First M1 for $h = 7.35(t - \frac{1}{2}) + \frac{1}{2}g(t - \frac{1}{2})^2$ or $h = 7.35t + \frac{1}{2}gt^2$

M0 if different *t* used in the two terms and M0 if two terms have opposite signs.

First A1 for appropriate *t* value used

Second M1, dependent, for equating their two expressions for *h*, but must have different *t*'s in the two expressions

Third M1, independent, for solving for their *t* (must have used two expressions etc.)

Second A1 for $t = 1$ (or $t = ½$)

Third A1 for $h = 4.9$

N.B. See alternative below where *t* is eliminated:

$h = \frac{1}{2}gt^2$	B1
$h = 7.35(t - \frac{1}{2}) + \frac{1}{2}g(t - \frac{1}{2})^2$	M1A1
$h = 7.35(\sqrt{\frac{2h}{g}} - \frac{1}{2}) + \frac{1}{2}g(\sqrt{\frac{2h}{g}} - \frac{1}{2})^2$	**DM**1
$h = 7.35\sqrt{\frac{2h}{g}} - 3.675 + 4.9(\frac{2h}{g} - \sqrt{\frac{2h}{g}} + 0.25)$	A1
$h = 4.9$	M1 A1

5.	$R = X\sin\alpha + 2g\cos\alpha$ $X\cos\alpha - F - 2g\sin\alpha = 2\times 1.45$ $F = 0.5R$ Eliminating R: solving for X $X = 45$	M1 A2 M1 A2 B1 **DM**1;**DM**1 A1 **10**
	NOTES **Question 5** First M1 for resolving perp to the plane.. First A2 for a correct equation; -1 each error. Second M1 for resolving parallel to the plane. Second A2 for a correct equation; -1 each error. (Allow F at this stage) B1 for $F = ½ R$ Third M1 dependent on previous two M's for eliminating R. Fourth M1 dependent on previous M for solving for X Third A1 for $X = 45$.	

6. (a)	x is greatest when rod is about to tip about B *i.e.* $R_A = 0$ (can be implied) $M(B),\ \ 2W(x-2l) = W\frac{1}{2}l$ $x = 2.25l$	B1 M1 A1 **DM**1 A1 (5)
(b)	Use of $R_A = 2W$ in an equation $M(B),\quad 2W(2l-x)+W\frac{1}{2}l = 2W.2l$ $x = 0.25l$	M1 M1 A1 A1 A1 (5) **10**

NOTES

Question 6(a)

B1 for x greatest when $R_A = 0$ (usually implied in moments equation) or correct use of $R_A \geq 0$.

First M1 for an equation in x and l ONLY (usually moments about B but could come from two equations). Allow if there is W (uncancelled) in each term. (M0 if R_A term included unless it subsequently becomes zero)

First A1 for a correct equation –again allow even if W has not been cancelled.

Second M1, dependent on previous M, for solving for x in terms of l.

Second A1 for $x = 2.25l$.

N.B. If 'l' omitted consistently and then inserted at end award full marks. If not inserted then can score max B1M1A0M1A0

Question 6(b) Scheme change

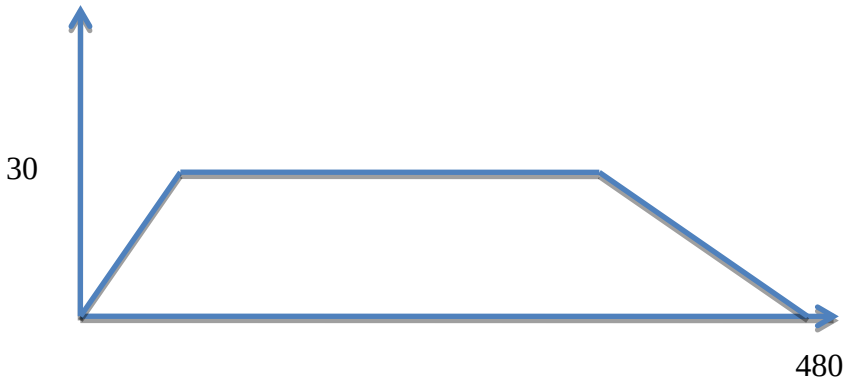
First M1 for use of $R_A = 2W$ in any equation (vertical resolution or moments) or for correct use of $R_A \leq 2W$.

Second M1 for an equation in x and l ONLY (usually moments about B but could come from two equations). Allow if there is W (uncancelled) in each term.

A2 for the equation, again allow even if W has not been cancelled,
-1 each error.

Third A1 for $x = 0.25l$.

N.B. If 'l' omitted consistently and then inserted at end award full marks. If not inserted then can score max M1M1A0A0A0.

7 (a)	$108\times1000/3600 = 30 \text{ m s}^{-1}$	M1 A1 (2)
(b)		B1 shape **DB1 ft** figs (2)
(c)	$12000 = \frac{1}{2}\times30(480+480-4T)$ $T = 40$ $a = 30/40 = 0.75 \text{ m s}^{-2}$	M1 A2 A1 M1 A1 (6) **10**

NOTES

Question 7(a)
M1 for 108 x 1000/3600 oe
A1 for 30

Question 7(b)
First B1 for trapezium (B0 for triangle), from the origin, finishing on the *t*-axis.
Second dependent B1 **ft** on their '30' and 480 or 108 and (8/60 oe).

Question 7(c)
First M1 for clear attempt at equating *total* area under a trapezium to distance travelled oe (equation must include at least one '1/2') to give equation in ONE unknown.
A2 for a correct equation , -1 each error. **N.B.** Repeated use of an incorrect v from part (a) is ONE error.
Third A1 for $T = 40$ (or 120)
N.B. (First M1 **only** for ½(480 + *x*).30 = 12000
First A1 for 480 – *x* = 160; Second A1 if they divide 160 in ratio 1:3)
(First M0 if they use *s* = the full distance in any single *suvat* equation)
Second M1 (independent) for a complete method to find *a*.
Fourth A1 for 0.75

8 (a)	For B: $1 = \frac{1}{2}a.2^2 \quad \Rightarrow \quad a = \frac{1}{2}$ m s^{-2}	M1 A1 (2)
(b)	$R = 3mg$; F=μR	B1 ; B1
	$T - F = 3m \times 0.5$	M1 A1**ft**
	$2mg - T = 2m \times 0.5$	M1 A1 **ft**
	Solving for μ	**DM**1
	$\mu = 0.58$ or 0.582	A1 (8)
(c)	$v = \frac{1}{2} \times 2 = 1$	B1 **ft**
	$-\mu \ 3mg = 3ma$	M1
	$0 = 1^2 - 2\mu gs$	M1
	$s = 0.0877\ldots$(.0.09 or better)	A1
	$s < 0.3$ correct conclusion,	**DM**1A1 cso (6)
		16

NOTES

Question 8(a)
First M1 for a complete method to find *a*. M0 if s =1.3 is used
First A1 for *a* =0.5

Question 8(b)
First B1 for $R = 3mg$
Second B1 for $F = \mu R$ seen (could be on diagram)
First M1 for resolving horizontally for *A* (this M mark can be scored if they just use *m* for mass but M0 if no mass used)
First A1ft on their *a*, for correct equation. (allow *F*)
Second M1 for resolving vertically for *B* (this M mark can be scored if they just use *m* for mass but M0 if no mass used)
Second A1ft on their *a*, for correct equation.
(Allow M2A2 for 'whole system' equation but M0 if not using 5*m*)
Third M1 dependent on both previous M marks for solving for μ
N.B. If *m* omitted consistently throughout (b), can score max B0B1M1A0M1A0M1A0

Question 8(c)
B1 **ft** for (their *a* x 2) oe to find *v*
First M1 for resolving horizontally for *A* with *T* = 0
Second M1 for a complete method (must have found a new '*a*') to find distance moved by *A*.
First A1 for 0.09 or better (0.087719..)
Third M1, dependent on first and second M marks, for comparison with 0.3 or 1.3 (Must explicitly refer to either 0.3 or 1.3 or an appropriate equivalent)
Second A1 **cso** for does not reach pulley.

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