Mark Scheme (Results)

Summer 2014

Pearson Edexcel GCE in Mechanics 3R (6679/01R)

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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 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 $\sqrt{}$ 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
1 (a)	$\frac{dv}{dx} = 3 \Rightarrow v = 3x - 3$ $a = 3(3x - 3)$ When $x = 5$, $F = 0.25 \times 3(15 - 3) = 9$ N	M1 A1 DM1 A1 (4)
(b)	$\frac{dx}{dt} = 3(x-1)$ $\int_2^5 \frac{dx}{(x-1)} = \int_0^t 3dt$ $\left[\ln(x-1)\right]_2^5 = 3t$ $t = \frac{1}{3}\ln 4 = 0.4620....$	M1 A1 DM1 A1 (4) **8**
Notes		
(a)	M1 Integration A1 correct integration DM1 using $a = v\,dv/dx$ with their v A1 correct integration	
(b)	M1 using $\frac{dx}{dt} = 3(x-1)$ A1 correct integrals with correct limits DM1 Substitute the limits A1 correct final answer	

Question Number	Scheme	Marks
2(a)	$T\sin 60^{\circ} + R\sin 60^{\circ} = mg$	M1 A1
	$T\cos 60^{\circ} - R\cos 60^{\circ} = ml\cos 60^{\circ}\omega^{2}$	M1 A1 A1
	$T = \frac{1}{2}m(l\omega^{2} + \frac{2}{\sqrt{3}}g)$	DM1 A1 (7)
(b)	$R = \frac{1}{2}m(\frac{2}{\sqrt{3}}g - l\omega^{2})$	M1 A1
	$\frac{1}{2}m(\frac{2}{\sqrt{3}}g - l\omega^{2}) > 0$	DM1
	$\omega < \sqrt{\frac{2g}{l\sqrt{3}}}$	A1
	$t > 2\pi\sqrt{\frac{l\sqrt{3}}{2g}}$ **	DM1 A1 (6)
		13

Notes

(a)	M1 vertical equation A1 correct vertical equation M1 horizontal equation, acceleration in either form A1 correct lhs A1 correct rhs DM1 solve for *T* A1 correct *T*
(b)	M1 obtain an expression for *R* A1 correct expression DM1 setting *R*> 0 A1 correct inequality for *w* DM1 obtaining an inequality for *t* A1 correct inequality

Question Number	Scheme	Marks
3 (a)	$R = mg\cos\theta$	B1
	WD against friction$=\mu xmg\cos\theta$	B1
	$\mu xmg\cos\theta = mgx\sin\theta - \dfrac{mgx^2}{2a}$	M1 A2
	$x = 2a(\sin\theta - \mu\cos\theta)$ **	A1 (6)
(b)	$T = \dfrac{mg2a(\sin\theta - \mu\cos\theta)}{a} = 2mg(\sin\theta - \mu\cos\theta)$	B1
	No motion if $T \le mg\sin\theta + \mu mg\cos\theta$	M1 A1
	$2mg(\sin\theta - \mu\cos\theta) \le mg\sin\theta + \mu mg\cos\theta$	DM1
	$\frac{1}{3}\tan\theta \le \mu$ **	A1 (5)
		11
	Notes	
(a)	B1 correct equation perpendicular to the plane B1 correct expression for work done against friction M1 work-energy equation A2 fully correct; A1 one error; A1 correct expression for x no errors in the working	
(b)	B1 use Hooke's law to obtain a correct expression for T M1 using NL2 parallel to the plane to set up an inequality for situation where no motion A1 correct inequality DM1 solving to get an inequality for μ A1 correct inequality and no errors in the working If only error is use of < instead of $\leqslant$, deduct final A mark only	

Question Number	Scheme	Marks
4(a)	$\frac{1}{2}mV^2 - \frac{1}{2}m\frac{2ag}{5} = mga(1-\cos\theta)$	M1 A1 A1
	$mg\cos\theta = m\frac{V^2}{a}$	M1 A1
	$V = \sqrt{\frac{4ag}{5}}$	DM1 A1 (7)
	$\cos\theta = \frac{4}{5}$	B1
(b)	$t = \frac{a - a\sin\theta}{V\cos\theta} \quad \left(= \sqrt{\frac{5a}{16g}}\right)$	M1 A1
	$s = Vt\sin\theta + \frac{1}{2}gt^2$	M1
	$= \sqrt{\frac{4ag}{5}}\sqrt{\frac{5a}{16g}}\frac{3}{5} + \frac{1}{2}g(\frac{5a}{16g})$	M1 A1
	$= \frac{73a}{160}$	A1
	$AX = a\cos\theta - \frac{73a}{160}$	M1
	$= \frac{11a}{32}$	A1 (9)
		16

Notes	
(a)	M1 energy equation A1 correct difference of KEs A1 fully correct equation M1 NL2 towards the centre. May include R A1 correct equation May include R DM1 set $R = 0$ and solve for V or V^2 A1 correct final answer with no errors in working
(b)	B1 for correct trig function for θ M1 using the horizontal distance and speed to obtain an expression for the time A1 correct expression M1 using $s = ut + \frac{1}{2}at^2$ to get the vertical distance M1 attempt at initial vertical velocity A1 correct initial vertical velocity A1 correct vertical distance M1 attempt distance AX A1 correct final answer

Question Number	Scheme	Marks
5. (a)	$\pi r^2 h \quad \pi(\tfrac{1}{4}r)^2(\tfrac{1}{4}h) \quad \pi r^2 - \pi(\tfrac{1}{4}r)^2(\tfrac{1}{4}h)$ $\tfrac{1}{2}h \quad \tfrac{1}{8}h \quad \bar{y}$	B2 B2
	$\pi r^2 h \tfrac{1}{2}h - \pi(\tfrac{1}{4}r)^2(\tfrac{1}{4}h)\tfrac{1}{8}h = \left[\pi r^2 - \pi(\tfrac{1}{4}r)^2(\tfrac{1}{4}h)\right]\bar{y}$	M1 A1ft
	$\bar{y} = \dfrac{85h}{168}$ **	A1 (7)
(b)	$0 - \pi(\tfrac{1}{4}r)^2(\tfrac{1}{4}h)\tfrac{1}{4}r = \left[\pi r^2 - \pi(\tfrac{1}{4}r)^2(\tfrac{1}{4}h)\right]\bar{x}$	M1 A1
	$\bar{x} = -\dfrac{r}{252}$	A1
	$\tan\alpha = \dfrac{\frac{85h}{168}}{\frac{r}{252}} = 17$	DM1 A1ft
	$r = 7.5h$	A1 (6) **13**

Notes	
(a)	B2 masses or volumes B2 all correct; B1 two correct B2 distances B2 all correct; B1 one of the known ones correct M1A1ft form a moments equation using their volumes and distances A1 correct result with no errors in the working
(b)	M1A1 form an equation to find the distance of the centre of mass from the axis of the cylinder A1 correct distance DM1 using their two distances to find the tan of the required angle (may be inverted) A1ft ratio is correct(inc correct way up) with their distances A1 correct answer

Question Number	Scheme	Marks
6(a)	$\frac{4mge}{l} = mg$	M1
	$e = \frac{1}{4}l$	A1 (2)
(b)	$mg - T = m\ddot{x}$	M1 A1
	$mg - \frac{4mg}{l}(x + \frac{1}{4}l) = m\ddot{x}$	M1
	$-\frac{4g}{l}x = \ddot{x}$	A1
	SHM, $\left(\text{with } \omega = \sqrt{\frac{4g}{l}}\right)$	A1 (5)
(c)	$\sqrt{gl} = a\sqrt{\frac{4g}{l}}$	M1 A1
	$a = \frac{1}{2}l$	A1 (3)
(d)	$-\frac{1}{4}l = \frac{1}{2}l \sin\sqrt{\frac{4g}{l}}t$	M1 A1
	$t = \frac{7\pi}{12}\sqrt{\frac{l}{g}}$	M1 A1 (4)
		14

Notes

(a)	M1 using Hooke's law to obtain an equation for e A1 correct answer
(b)	M1 using NL2 vertically A1 correct equation M1 using Hooke’s law to replace T with an expression for x. These 3 marks can be gained with a instead of $\ddot{x}$ A1 fully correct, simplified equation A1 conclusion with all work correct
(c)	M1 using $v = aw$ A1 correct equation A1 correct amplitude
(d)	M1 for an equation to find required time A1 correct equation M1 solving their equation must be in radians and must give a positive value A1 correct time decimal equivalent acceptable.

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