Mark Scheme (Results)

Summer 2018

Pearson Edexcel GCE Further Mathematics
AS Further Mechanics M1 Paper 8FM0_25

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- 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.
- 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/indicative content will not be exhaustive.

EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 40.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. 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. 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.

5. Where a candidate has made multiple responses and indicates which response they wish to submit, examiners should mark this response.
   If there are several attempts at a question which have not been crossed out, examiners should mark the final answer which is the answer that is the most complete.

6. Ignore wrong working or incorrect statements following a correct answer.

7. Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternatives answers are provided in the notes. If examiners are not sure if an answer is acceptable, they will check the mark scheme to see if an alternative answer is given for the method used

Question	Scheme	Marks	AOs
1(a)	Speed just before impact: $v^2 = u^2 + 2as = 2\times 9.8\times 3.6 \left(= 70.56\right)$	M1	3.4
	$v = 8.4$ (m s^{-1})	A1	1.1b
	Use of $I = mv - mu$: $4.2 = 0.3\left(w - \left(-8.4\right)\right)$	M1	3.1b
	Follow their 8.4	A1ft	1.1b
	$w = 5.6$ (m s^{-1})	A1	1.1b
		(5)	
1(b)	KE lost $= \frac{1}{2}m\left(v^2 - w^2\right)$	M1	3.3
	$= \frac{0.3}{2}\left(8.4^2 - 5.6^2\right)$ Follow their 8.4 and 5.6	A1ft	1.1b
	$= 5.88$ (J)	A1	1.1b
		(3)	
			(8 marks)

Notes

(a) M1: Use the model and *suvat* or energy to find speed before impact

A1: Correct answer. Accept $\sqrt{70.56}$, $\sqrt{7.2g}$

M1: A complete strategy to find *w*: Use the model and impulse-momentum equation using given impulse and their speed of impact. Must be using a difference in velocities. Be vigilant for sign fudges that make the original equation incorrect.

A1ft: Correct unsimplified equation using their speed

A1: Correct positive answer

(b) M1: Correct method to find the KE lost in the impact. Need to be using speeds immediately before and immediately after impact.

A1ft: Correct expression for their speeds. Accept subtraction either way round

A1: Correct solution only. Accept 5.9

Question	Scheme	Marks	AOs
2(a)	Work-energy equation: KE lost = PE gained + Work Done	M1	2.1
	$\frac{1}{2}\times 4\times 5^2 - 4\times g\times 2.5\times \sin\theta = 2.5R$	A1	1.1b
	$\frac{1}{2}\times 4\times 5^2 - 4\times g\times 2.5\times \frac{2}{7} = 2.5R$	A1	1.1b
	$2.5R = 22 \Rightarrow R = 8.8$ *	A1*	1.1b
		(4)	
(b)	Work-energy equation: KE after =initial KE – 2 (Work Done)	M1	3.3
	$\frac{1}{2}\times 4\times v^2 = \frac{1}{2}\times 4\times 25 - 2\times 8.8\times 2.5$	A1	1.1b
	$\Rightarrow 2v^2 = 6,\ v = 1.7\ (\text{m s}^{-1})$	A1	1.1b
		(3)	
(b) alt	Work-energy equation: KE at B = PE lost – Work Done	M1	
	$\frac{1}{2}\times 4\times v^2 = 4\times 9.8\times \frac{2}{7}\times 2.5 - 8.8\times 2.5$	A1	
	$\Rightarrow 2v^2 = 6,\ v = 1.7\ (\text{m s}^{-1})$	A1	
		(3)	
(b) alt	Equation of motion and *suvat*: $4g\sin\theta - 8.8 = 4a \quad (a = 0.6)$	M1	
	$v^2 = 2\times a\times 2.5$	A1	
	$v = 1.7\ (\text{m s}^{-1})$	A1	
		(3)	
(c)	A valid improvement	B1	3.5c
	A second valid, distinct, improvement	B1	3.5c
		(2)	
			(9 marks)

Notes
(a) M1: A complete method to obtain R. The question requires the use of work-energy. Need to consider all three terms with no duplication. Condone sign error and sin/cos confusion. **A1:** Unsimplified equation with at most one error **A1:** Correct unsimplified **A1*:** Correct answer with sufficient working shown to justify **given answer**
(b) M1: Work-energy equation considering $A \to A$ or $B \to A$. Requires all relevant terms with no duplication. Condone sign errors and sin/cos confusion **A1:** Correct unsimplified equation **A1:** Accept 1.7 or 1.73 (answer depends on use of g). Not $\sqrt{3}$
(b) alt M1: Complete method to find v or v^2. **A1:** Correct unsimplified expression for v or v^2. **A1:** Accept 1.7 or 1.73 (answer depends on use of g)
(c) B1: it has assumed a constant resistance - have variable resistance – have air resistance proportional to speed ……

Question	Scheme	Marks	AOs
3(a)	Use of $P = Fv$	B1	1.1a
	Equation of motion: $F - \lambda v = 750 \times 0.6$	M1	2.1
	$\frac{18000}{15} - \lambda \times 15 = 750 \times 0.6$	A1	1.1b
	$1200 - 15\lambda = 450 \Rightarrow \lambda = 50$ *	A1*	1.1b
		(4)	
3(b)	Overall strategy	M1	3.1b
	Equation of motion	M1	3.4
	$\frac{12000}{V} - 50V - 750g\sin\alpha = 0$	A1	1.1b
	$\frac{12000}{V} - 50V - 490 = 0 \Rightarrow 5V^2 + 49V - 1200 = 0$	A1	1.1b
	$\Rightarrow V\left(= \frac{-49 + \sqrt{49^2 + 20 \times 1200}}{10}\right) = 11.3$ only	A1	1.1b
		(5)	
			(9 marks)

Notes

(a) B1: Use of $P = Fv$ seen or implied. Allow in (b) if not seen in (a)

M1: Requires all three terms. Must be dimensionally correct.
Need not have substituted for F. Condone sign errors.
Allow if equation not seen but all steps in working correct.
The method needs to show that $\lambda = 50$ is the only solution.

A1: Correct unsimplified equation

A1: Obtain given answer correctly

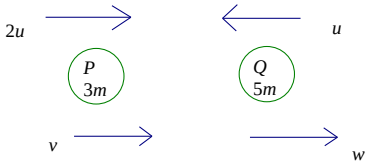
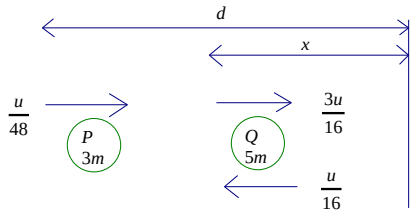
(b) M1: Complete strategy e.g. use the model to form quadratic in V and solve for V

M1: Use the model to form equation of motion. All terms required.
Condone sign errors and sin/cos confusion.
Need not have substituted for F.

A1: Substituted equation with at most one error (unsimplified). Allow in F or V.

A1: Correct quadratic equation. e.g. $5V^2 + 49V - 1200 = 0$ or equivalent
Allow in F or V.

A1: Accept 11 or 11.3 (follows use of 9.8)
Negative root should be rejected if seen

Question	Scheme	Marks	AOs
4(a)	Complete strategy to find speed of Q	M1	3.1b
			
	Use of CLM	M1	3.1a
	$6mu-5mu\left(=mu\right)=3mv+5mw$	A1	1.1b
	Use of impact law	M1	3.1a
	$w-v=3ue$	A1	1.1b
	$\left.\begin{array}{l}3v+5w=u\\3w-3v=9ue\end{array}\right\}\Rightarrow 8w=u+9ue\ ,\quad w=\frac{u}{8}\left(9e+1\right)*$	A1*	2.1
		(6)	
4(b)	$v=w-3ue=\frac{u}{8}\left(1-15e\right)$ and $v>0$	M1	3.1b
	$\Rightarrow\ \left(0\leq\right)e<\frac{1}{15}$	A1	1.1b
		(2)	
4(c)	Complete strategy to find time for Q to get to second collision	M1	3.1a
	Speed of Q after impact with wall $=\frac{u}{16}$	B1	1.1b
			
	Time for Q: $\frac{16d}{3u}+\frac{16x}{u}$ follow their $\frac{u}{16}$ and $\frac{16d}{3u}$	A1ft	1.1b
	Complete strategy to find time for P to get to second collision $=\frac{48\left(d-x\right)}{u}$	B1ft	1.1b
	Use both at the same place at the same	M1	2.1
	$x=\frac{128d}{192}=\frac{2d}{3}$	A1	1.1b
		(6)	

Question	Scheme	Marks	AOs
4(c) alt	Complete strategy to find position of second collision	M1	3.1a
	Speed of Q after impact with wall $=\frac{u}{16}$	B1	1.1b
	Distance apart when Q strikes the wall $=\frac{8d}{9}$	B1ft	1.1b
	Gap closing at $\frac{u}{16}+\frac{u}{48}$	A1ft	1.1b
	$t=\dfrac{\frac{8d}{9}}{\frac{u}{16}+\frac{u}{48}} \quad \left(=\frac{32d}{3u}\right)$	M1	2.1
	$x=\frac{u}{16}\times\frac{32d}{3u}=\frac{2d}{3}$	A1	1.1b
		(6)	
4(c) alt	Complete strategy to find position of second collision	M1	3.1a
	Speed of Q after impact with wall $=\frac{u}{16}$	B1	1.1b
	Distance apart when Q strikes the wall $=\frac{8d}{9}$	B1ft	1.1b
	Ratio of speeds: $v_Q : v_P = 3:1$	A1ft	1.1b
	Distance travelled by $Q=\frac{3}{4}\times\frac{8d}{9}$	M1	2.1
	$x=\frac{2d}{3}$	A1	1.1b
		(6)	
			(14 marks)

Notes
(a) M1: Complete strategy e.g. use of CLM, impact law and solution of simultaneous equations. **M1:** CLM equation. Requires all terms and dimensionally correct. Condone sign errors. **A1:** Correct unsimplified equation **M1:** Impact law. Condone sign error. Must be used the right way round. **A1:** Correct unsimplified equation Signs consistent with CLM equation. **A1*:** Obtain **given answer** from correct working
(b) M1: Find speed of P and form correct inequality consistent with their directions. **A1:** Correct solution. Need not mention the lower limit.
(c) M1: Complete strategy e.g. find time to wall and back again **B1:** Correct use of impact law **A1ft:** Correct unsimplified equation using $\text{time} = \frac{\text{distance}}{\text{speed}}$ and following their $\frac{u}{16}$ and $\frac{16d}{3u}$ **B1ft:** Correct use of $\text{time} = \frac{\text{distance}}{\text{speed}}$ Follow their $\frac{u}{48}$ **M1:** find x by putting both particles in the same place at the same time. Must be valid expressions for the times. **A1:** Correct answer or exact equivalent
(c) alt M1: e.g. by considering distances and relative velocities **B1:** Correct use of impact law **B1ft:** Follow their $\frac{u}{48}$ and $\frac{3u}{16}$ **A1ft:** Follow their $\frac{u}{16}$ and $\frac{u}{48}$ **M1:** Correct use of $\text{time} = \frac{\text{distance}}{\text{speed}}$ **A1:** Correct answer
(c) alt M1: e.g. by considering distances and relative velocities **B1:** Correct use of impact law **B1ft:** Follow their $\frac{u}{48}$ and $\frac{3u}{16}$ **A1ft:** Follow their $\frac{u}{16}$ and $\frac{u}{48}$ **M1:** Correct use of ratio to find x **A1:** Correct answer

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