Mark Scheme (Results)

Summer 2018

Pearson Edexcel GCE Further Mathematics
AS Further Mechanics M2 Paper 8FM0_26

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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.

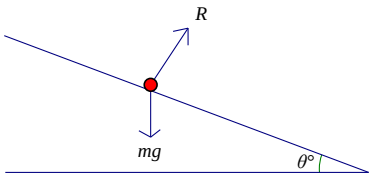
7. Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternatives answers are provided in the notes. If examiners are not sure if an answer is acceptable, they will check the mark scheme to see if an alternative answer is given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

Question	Scheme	Marks	AOs
1(a)	Complete strategy to find d	M1	3.1b
	$\frac{5}{30}M\times\frac{5}{2}a+\frac{13}{30}M\times\frac{5}{2}a=M\times d$	A1	1.1b
	$\left(\frac{25}{2}a+\frac{65}{2}a=30d\right)$	A1	1.1b
	$90a=60d \Rightarrow d=\frac{3}{2}a$ *	A1*	2.1
		(4)	
1(b)	Complete strategy to find k, e.g. by use of a moments equation	M1	3.1b
	$Mg\times\frac{3}{2}a=kMg\times 12a$	A1	1.1b
	$k=\frac{1}{8}$	A1	1.1b
		(3)	
1(b) alt	Moments equation	M1	
	$12a\times kM=\frac{13}{30}M\times 2.5a+\frac{5}{30}M\times 2.5a$	A1	
	$12k=\frac{45}{30}$, $k=\frac{1}{8}$	A1	
		(3)	
			(7 marks)

Notes

(a) M1: Complete strategy to find d e.g. moments about AB or a parallel axis. Needs all relevant terms. Must be dimensionally correct.
Condone sign errors. M's might cancel from the start.
A1: Unsimplified equation with at most one error
A1: Correct unsimplified equation
A1*: Obtain the **given answer** from a convincing argument

(b) M1: Complete strategy to find k e.g. moments about A.
Needs all relevant terms. Must be dimensionally correct.
Condone sign errors. Condone if a, M, g missing throughout
A1: Correct unsimplified equation in k
A1: Correct answer – any equivalent form

Question	Scheme	Marks	AOs
2(a)	Complete strategy to find value of θ	M1	3.1b
			
	Resolve vertically	M1	3.1b
	$R\cos\theta° = mg$	A1	1.1b
	Resolve horizontally	M1	3.1b
	$R\sin\theta° = \frac{mv^2}{r}$	A1	1.1b
	$v = 80 \text{ km h}^{-1} = \frac{80\times1000}{60^2} \text{ m s}^{-1}$	B1	1.2
	Solve simultaneous equations and substitute v in correct units to obtain θ : $\tan\theta° = \frac{v^2}{rg} = \frac{640000}{36^2\times500\times9.8}$, $\theta = 5.8$	A1	2.2a
		(7)	
(b)	All weight acting at a single point	B1	3.5b
		(1)	
(c)	Friction acting down the slope	B1	2.2a
		(1)	
			(9 marks)

Notes

(a) M1: Complete strategy involving resolving in perpendicular directions, change of units and solution of simultaneous equations

M1: Complete strategy to form one equation involving θ e.g. resolve vertically. Condone sin/cos confusion

A1: Or equivalent

M1: Complete strategy to form a second equation involving θ e.g. resolve horizontally. Condone sin/cos confusion

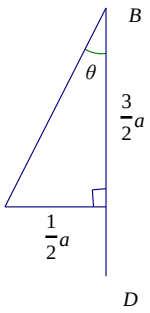
A1: Correct unsimplified – need not substitute for v or r

B1: Correct conversion km h^{-1} to m s^{-1} (22.2)

A1: Accept 5.8 or 5.75 (follows use of 9.8)

(b) B1: Any appropriate comment
e.g. Only one point of contact with the road
The centre of mass of the car is on the road.

(c) B1: Need to include the direction

Question	Scheme	Marks	AOs
3(a)	L is symmetrical about AD	B1	2.4
		(1)	
3(b)	<table><tr><td></td><td>$ABDF$</td><td>BCD</td><td>DEF</td><td>L</td></tr><tr><td>Mass ratio</td><td>$4a^2 \times M$</td><td>$a^2 \times 3M$</td><td>$a^2 \times 3M$</td><td>$10a^2 \times M$</td></tr><tr><td>C of M from BE</td><td>$-a$</td><td>$+\frac{a}{3}$</td><td>$-\frac{2a}{3}$</td><td>x</td></tr></table>		
	Mass ratios	B1	1.2
	Distances from BE	B1	1.2
	Moments equation	M1	2.1
	$-a \times 4a^2M + \frac{a}{3} \times 3a^2M - \frac{2a}{3} \times 3a^2M = 10a^2M \times x$ $\left(-4a + a - 2a = 10x\right)$	A1	1.1b
	$x = -\frac{5a}{10} = -\frac{a}{2}$	A1	1.1b
	Use symmetry and Pythagoras	M1	1.1a
	Distance from $D = \sqrt{\frac{a^2}{4} + \frac{a^2}{4}} = \frac{\sqrt{2}}{2}a$ *	A1*	2.2a
		(7)	
3(c)			
	Trig ratio of a relevant angle	M1	1.2
	$\tan\theta = \frac{1}{3}$ or $\cos\theta = \frac{\frac{10}{4}a^2 + 4a^2 - \frac{2}{4}a^2}{2 \times \frac{\sqrt{10}}{2}a \times 2a} = \frac{6}{2\sqrt{10}}$	A1ft	1.1b
	$\theta = 18.4°$	A1	1.1b
		(3)	
			(11 marks)

Notes
(a) B1: Any equivalent statement about the symmetry
(b) B1: Correct mass ratios **B1:** Distance ratios from any horizontal or vertical axis **M1:** Moments equation for complete lamina about any horizontal or vertical axis. Must be dimensionally correct **A1:** Correct unsimplified equation for their axes **A1:** Correct horizontal or vertical distance from D **M1:** Use of Pythagoras with their distance **A1*:** Obtain given answer from correct working.
(c) M1: Trig ratio of θ or $90° - \theta$ or equivalent **A1ft:** Correct unsimplified expression using their $\frac{a}{2}$ **A1:** Correct angle. Accept 0.322 radians

Question	Scheme	Marks	AOs
4(a)	$\int \frac{1}{4}\mathrm{d}t = \int \frac{1}{50-10v}\mathrm{d}v$	M1	3.1a
	$\frac{1}{4}t = -\frac{1}{10}\ln(50-10v)(+C)$	A1	1.1b
	$\frac{1}{4}t = -\frac{1}{10}\ln(50-10v)+\frac{1}{10}\ln 50$	M1	1.1b
	$-\frac{5t}{2} = \ln\left(\frac{5-v}{5}\right)$	M1	1.1b
	$v = 5\left(1-e^{-2.5t}\right)$ *	A1*	2.1
		(5)	
4(b)	limiting value is 5	B1	2.2a
		(1)	
4(c)	Equation in x and t: $\frac{\mathrm{d}x}{\mathrm{d}t} = 5\left(1-\mathrm{e}^{-2.5t}\right)$	M1	1.1a
	$\Rightarrow \int 1\mathrm{d}x = \int 5\left(1-\mathrm{e}^{-2.5t}\right)\mathrm{d}t$	M1	1.1b
	$x = 5t + 2e^{-2.5t}(+C)$	A1	1.1b
	Use $v = 2.5$ and $v = 5\left(1-e^{-2.5t}\right)$ to find value of t	M1	3.1a
	$1-\frac{2.5}{5} = \mathrm{e}^{-2.5t} \Rightarrow t = \frac{2}{5}\ln 2$	A1	1.1b
	$\left[x\right]_0^d = \left[5t + 2e^{-2.5t}\right]_0^{\frac{2}{5}\ln 2}$	M1	2.1
	$d = 2\ln 2 - 1$ *	A1*	1.1b
		(7)	
			(13 marks)

Notes
(a) M1: Strategy to find v and attempt the integration **A1:** Correct integration **M1:** Use boundary conditions as limits or evaluate constant of integration in an expression involving $\lambda \ln(a+bv)$ and μt **M1:** Remove logarithm to express v in terms of t **A1*:** Obtain given answer from correct working
(b) B1: Correct answer from correct working
(c) M1: Set up equation of motion in terms of x and t **M1:** Separate variables and attempt integration of both sides **A1:** Any equivalent form. Condone if $+C$ not seen **M1:** Use $v = 2.5$ to find limit for t **A1:** Any equivalent exact form. (0.277) **M1:** Use boundary conditions as limits or evaluate constant of integration in an expression involving λt and $\mu e^{-2.5t}$ **A1*:** Sufficient correct working to justify given answer

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