Mark Scheme

Summer 2023

Pearson Edexcel GCE

Advanced Subsiduary Level

Further Mathematics (8FM0)

Paper 26 : Further Mechanics 2

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Summer 2023
Publications Code 8FM0_26_2306_MS*

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.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

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
1a	Moments about *y* axis:	M1	2.1
	$km\times -1+4m\times -3+2m\times 6=(k+6)m\times \bar{x}$	A1	1.1b
	$\Rightarrow \bar{x}=\dfrac{-k}{k+6}$ *	A1*	1.1b
		(3)	
1b	Moments about *x* axis: $\left(km\times 5+4m\times -1+2m\times 1=(k+6)m\times \bar{y}\right)$	M1	3.1a
	$\Rightarrow \bar{y}=\dfrac{5k-2}{k+6}$	A1	1.1b
		(2)	
1c	$\bar{y}=2\bar{x}+3\Rightarrow \dfrac{5k-2}{k+6}=\dfrac{-2k}{k+6}+3$ $\left(5k-2=-2k+(3k+18)\right)$	M1	1.1b
	$\Rightarrow k=5$	A1	1.1b
		(2)	
1d	$4=2\lambda+3\Rightarrow$	M1	3.4
	$\lambda=\dfrac{1}{2}$	A1	1.1b
		(2)	
			(9 Marks)

Notes:

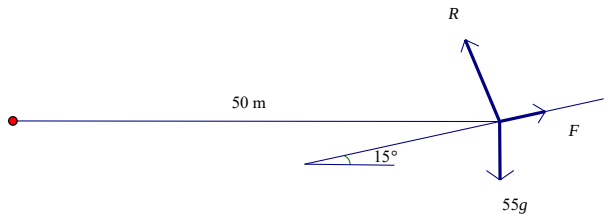
1a	**M1**	Moments about *y* axis (or a parallel axis). All terms required. Dimensionally consistent. Condone sign errors.
	A1	Correct unsimplified equation
	A1*	Obtain given answer from full and correct working Accept with $6 + k$
1b	**M1**	Moments about *x* axis (or a parallel axis). All terms required. Dimensionally consistent. Condone sign errors.
	A1	Correct unsimplified expression for $\bar{y}$. Any equivalent simplified form
		The first 5 marks are available for a combined equation in vector form
1c	**M1**	Correct use of their $\bar{y}$ and given $\bar{x}$ to find *k*.
	A1	Correct only

1d	**M1**	Use the model to obtain λ =….. or x = …. If working from the beginning and the new particle has mass M then $\frac{23+4M}{11+M} = 2\left(\frac{-5+\lambda M}{11+M}\right)+3$
	A1	Accept $x=\frac{1}{2}$

Question	Scheme	Marks	AOs
2a	Use of $a = \dfrac{\mathrm{d}v}{\mathrm{d}t}$	M1	3.1a
	$a = 2\mathrm{e}^{2t} + 6\mathrm{e}^{t} - k$	A1	1.1b
	Substitute $t = \ln 2$ into their acceleration and solve for k	M1	1.1b
	$k = 20$	A1	2.2a
		(4)	
2b	Use of $v = \dfrac{\mathrm{d}x}{\mathrm{d}t}$	M1	2.1
	$x = \dfrac{1}{2}\mathrm{e}^{2t} + 6\mathrm{e}^{t} - \dfrac{k}{2}t^{2}\,(+C)$	A1ft	1.1b
	Correct use of boundary conditions in their x	M1	3.1a
	$x = 2 + 12 - 10(\ln 2)^{2} - \left(\dfrac{1}{2} + 6\right)\left(= 7.5 - 10(\ln 2)^{2}\right) = 2.7$ to 2 s.f.	A1	1.1b
		(4)	
			(8 marks)

Notes:

2a	M1	Use the model and differentiate v to obtain a. Obtain form $p\mathrm{e}^{2t} + q\mathrm{e}^{t} - k$
	A1	Correct only
	M1	$(2\times 4 + 6\times 2 - k = 0)$ Their acceleration must come from an attempt to differentiate.
	A1	Correct only
2b	M1	Integrate v to obtain x. Obtain form $a\mathrm{e}^{2t} + b\mathrm{e}^{t} + ct^{2}$
	A1ft	Allow in k or their k
	M1	Use the model to evaluate constant of integration or use boundary conditions as limits in a definite integral. Their x must come from an attempt to integrate.
	A1	2sf only

Question	Scheme	Marks	AOs
3			
	They need to form two equations, they could be in either order. Mark in the order seen.		
	Equation of motion horizontally	M1	3.4
	$\frac{55\times 4.5^2}{50} = R\sin 15° - F\cos 15°$	A1 A1	1.1b 1.1b
	Resolve vertically	M1	3.4
	$55g = R\cos 15° + F\sin 15°$	A1ft A1ft	1.1b 1.1b
	Uses $F = \mu R$	B1	1.2
	Solve for μ	dM1	3.1b
	$\mu = 0.22$ or $\mu = 0.224$	A1	2.2a
		(9)	
			(9 marks)

Notes:

M1	First equation: Dimensionally correct. Condone sign errors and sine / cosine confusion
A1	Unsimplified equation with at most one error
A1	Correct unsimplified equation
M1	Second equation: Dimensionally correct. Condone sign errors and sine / cosine confusion
A1ft	Unsimplified equation with at most one error. Follow their direction for *F* parallel to the slope
A1ft	Correct unsimplified equation. Follow their direction for *F* parallel to the slope
B1	Seen anywhere in the solution
dM1	Complete method to obtain μ. Dependent on both previous M marks
A1	Value correct 2 or 3 sf (follows 9.8)

Question	Scheme	Marks	AOs
4a	M(CM)	M1	2.1
	$36a^2 \times 2a = \left(162a^2 - 36a^2\right)d \quad \left(=126a^2d\right)$	A1 A1	1.1b 1.1b
	$d = \frac{4}{7}a \quad *$	A1*	2.2a
		(4)	
4b	M(A)	M1	3.1b
	$T \times 18a = W \times \left(9a + \frac{4}{7}a\right)$	A1	1.1b
	$T = \frac{67}{126}W$	A1	1.1b
		(3)	
4c	M(AB)	M1	2.1
	$126a^2\bar{y} = 162a^2 \times 6a - 36a^2 \times \left(6a + 4a\right)$	A1 A1	1.1b 1.1b
	$\bar{y} = \frac{34}{7}a$	A1	1.1b
	Correct use of trig	M1	3.1b
	$\tan\theta = \frac{34}{67}$	A1ft	1.1b
	$\theta = 27$ or better	A1	2.2a
		(7)	
			(14 marks)

Notes:		
4a	M1	Form moments equation about *CM* or a parallel axis. Must be dimensionally correct. Condone sign errors.
	A1	Unsimplified equation with at most one error
	A1	Correct unsimplified equation
	A1*	Obtain **given answer** from correct working
4b	M1	Complete method to find the required tension e.g. take moments about *A*. Must be dimensionally correct. Condone sign errors.
	A1	Correct unsimplified equation
	A1	Or equivalent (0.53*W* or better) (0.53174…*W*)
4c	M1	Complete method to find a relevant vertical distance for the centre of mass of *L* e.g. take moments about *AB.* Condone sign errors.
	A1	Unsimplified equation with at most one error
	A1	Correct unsimplified equation
	A1	Seen or implied
	M1	Correct use of trig and the given answer to part (a) to find a relevant angle
	A1ft	Correct unsimplified equation for the required angle. Follow their $\bar{y}$
	A1	27 or better (26.906……)

Pearson Education Limited. Registered company number 872828

with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom