Mark Scheme (Results)

Summer 2024

Pearson Edexcel GCE
In Further Mathematics (8FM0)
Paper 25 Further Mechanics 1

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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.
- 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.

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	Scheme	Marks	AOs
1a	Use of CLM:	M1	3.1a
	$2m\times 2u-3mu=-2m\times 0.5u+3mw$ **OR:** $(I=)\ \ 2m(0.5u--2u)=3m(w--u)$	A1	1.1b
	$w=\frac{2u}{3}$ accept $0.67u$ or better	A1	1.1b
		(3)	
1b	Use of NEL	M1	3.4
	$e=\frac{0.5u+\frac{2u}{3}}{2u+u}$	A1ft	1.1b
	$\frac{7}{18}$ accept 0.39 or better	A1	1.1b
		(3)	
1c	Use of impulse-momentum principle for A or B	M1	3.1a
	$\pm 2m(0.5u--2u)$ **OR** $\pm 3m(\frac{2u}{3}--u)$	A1	1.1b
	$5mu$	A1	1.1b
		(3)	
			(9 marks)

Notes

1a	M1	Use of CLM, with correct no. of terms, condone consistent extra g's, sign errors, cancelled m's, to produce an equation in (m), u and w only. **OR:** Use of two imp-mom equations, with I then eliminated, to produce an equation in (m), u and w only, condone consistent extra g's, sign errors, cancelled m's. **N.B.** Allow the use of another letter for w in the working.
	A1	Correct equation in (m), u and their w only.
	A1	Cao. Must see $w = ku$
1b	M1	Use of NEL, must be the right way up with the 'correct' terms but condone sign errors. Allow without the u's
	A1ft	Correct unsimplified expression, ft on their w
	A1	cao
1c	M1	Correct structure but condone sign errors (M0 if g included or m's missing) Can score this mark if they use m for the mass with a 'correct' pair of velocities.
	A1	Correct equation
	A1	cao

Question	Scheme	Marks	AOs
2a	Use of $F = \frac{84000}{12}$	M1	3.4
	Equation of motion horizontally	M1	3.1b
	$\frac{84000}{12} - 490 \times 12 = 5000a$	A1	1.1b
	$\frac{28}{125}$ or 0.224 or 0.22 (m s^{-2})	A1	1.1b
		(4)	
2b	Use of $D = \frac{84000}{V}$	M1	3.4
	Equation of motion parallel to the road: $D - 490V - 5000g\sin\alpha = 0$	M1	2.1
	$\frac{84000}{V} - 490V - 5000g\sin\alpha = 0$	A1	1.1b
	$V = 10$ only	A1	1.1b
		(4)	
			(8 marks)

Notes		
2a	M1	Allow use of 84
	M1	Correct no. of terms, condone sign errors. Allow if they use 84 or 84000 as the driving force
	A1	Correct equation
	A1	Accept 0.22
2b	M1	Allow use of 84
	M1	Equation in V only with correct no. of terms,A condone sign errors and sin/cos confusion and omitted g with D in terms of V.
	A1	Correct equation in V only
	A1	cao

Question	Scheme	Marks	AOs
3a	Use the principle of conservation of mechanical energy and model	M1	3.4
	$\frac{1}{2}mW^2 - \frac{1}{2}m\left(\sqrt{2gh}\right)^2 = mgh$	A1	1.1b
		A1	1.1b
	$W = \sqrt{4gh} = 2\sqrt{gh}$	A1	1.1b
		(4)	
3b	$R = mg\cos\theta$	M1	3.3
	$F = \frac{1}{3}R$	M1	3.4
	$F = \frac{4}{15}mg$	A1	1.1b
		(3)	
3c	Use the work-energy principle and the model:	M1	3.4
	A to B: $mgd\sin\theta - \frac{1}{2}m\left(\sqrt{2gh}\right)^2 = \frac{4}{15}mgd$	A1ft	1.1b
	or $mg(h + d\sin\theta) - mgh - \frac{1}{2}m\left(\sqrt{2gh}\right)^2 = \frac{4}{15}mgd$ **OR** A to the ground: $mg(h + d\sin\theta) - \frac{1}{2}m\left(\sqrt{4gh}\right)^2 = \frac{4}{15}mgd$	A1ft	1.1b
	Solve for d in terms of h or h in terms of d	M1	1.1b
	$d = 3h$	A1	1.1b
		(5)	
			(12 marks)

Notes				
3a	M1	Correct number of terms, dimensionally correct, condone sign errors M0 if they use $v^2 = u^2 + 2as$		
	A1	Correct equation with at most one error		
	A1	Correct equation		
	A1	Either (need $W =$)		
3b	M1	Condone sin/cos confusion and allow cos($\frac{4}{5}$) etc		
	M1	$F = \frac{1}{3}R$		
	A1	Accept 0.27 mg or better		
3c	M1	Correct number of terms, dimensionally correct, condone sign errors and sin/cos confusion and allow cos($\frac{4}{5}$) etc		

	A1ft	Correct equation with at most one error		
	A1ft	Correct equation ft on their answer to (b) (and (a) if they use A to the ground.)		
	M1	Solve for d, must have at least 3 terms, with two of them in d		
	A1	cao		
		N.B. No marks available if they don't use work-energy		

Question	Scheme	Marks	AOs
4a	Use of CLM **OR** NEL	M1	3.1a
	$mu = -m\frac{u}{5}(4e-1) + 4mv_Q$ $\quad v_Q + \frac{u}{5}(4e-1) = eu$	A1	1.1b
	$v_Q = \frac{u}{5}(e+1)$	A1	1.1b
		(3)	
4b	$v_P = \pm\frac{fu}{5}(4e-1)$	B1	3.3
	$= \pm\frac{2fu}{5}$	B1	1.1b
	KE Loss $= \frac{1}{2}m\left(\frac{2u}{5}\right)^2 - \frac{1}{2}m\left(\frac{2fu}{5}\right)^2$	M1	3.1a
	$= \frac{2mu^2}{25}(1-f^2)$	A1	1.1b
		(4)	
4c	$v_Q = \frac{7u}{20}$	M1	1.1b
	$\frac{7u}{20} < \frac{2fu}{5}$	M1	2.1
	$\frac{7}{8} < f$ „ 1	A1 B1	1.1b 1.2
		(4)	
			(11 marks)

Notes

4a	M1	CLM: Correct no. of terms, condone consistent extra *g*'s, sign errors, cancelled *m*'s **OR** NEL: *e* on the correct side but condone sign errors
	A1	Correct equation
	A1	Cao. Accept any equivalent two term expression.
4b	B1	Seen or implied.
	B1	Seen or implied.
	M1	Allow negative of this and without *e* being substituted. **N.B.** Allow anything of the form: $\pm\left(\frac{1}{2}m(v_P)^2 - \frac{1}{2}m(fv_P)^2\right)$, provided that v_P has come from an attempt to put $e = \frac{3}{4}$ in the given expression
	A1	Cao. Accept any equivalent two term expression, isw

4c	M1	For attempt to put $e = \frac{3}{4}$ in their v_Q expression to give a multiple of *u*, seen or implied at some stage.
	M1	Correct inequality for their speeds (which could involve *e*), provided it's dimensionally correct Not available if *Q* is moving towards the wall.
	A1	$\frac{7}{8} < f$ oe
	B1	For $f \leqslant 1$
		N.B. All the marks are available if they go straight to $\frac{7}{20} < \frac{2f}{5}$

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