Pearson Edexcel

Mark Scheme (Results)

November 2021

Pearson Edexcel GCE
In AS 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
1(a)	Resolve perpendicular to the plane	M1	3.4
	$R = \frac{4}{5}mg$	A1	1.1b
		(2)	
(b)	Work done against friction = $0.4R \times 0.5$ (= $0.16mg$)	M1	3.4
	PE Loss = $mg \times 0.5\sin\alpha + 0.8mg$ (= $1.1mg$)	M1	1.1b
	Using work-energy principle	M1	3.4
	$1.1mg = 0.16mg + \frac{1}{2}mv^2$	A1	1.1b
	v = 4.3 or 4.29 (m s^{-1})	A1	1.1b
		(5)	
			(7 marks)

Notes:

1a	M1	Allow sin/cos confusion
	A1	cao
1b	M1	Correct form for work done against friction. (1.568m)
	M1	Correct no. of terms, dimensionally correct, condone sin/cos confusion (10.78m)
	M1	Correct number of terms (using their WD and PE for the **whole journey** to the floor)
	A1	Correct unsimplified equation
	A1	Either of the two possible answers (as g = 9.8 has been used)

Question	Scheme	Marks	AOs
2(a)	Speeds after 1st and 2nd impacts: eu and e^2u	B1	3.4
	KE Loss, $K = \frac{1}{2}emu^2 - \frac{1}{2}em(e^2u)^2$ (difference in KE's)	M1	3.3
	$\frac{1}{2}mu^2(e-e^5)$	A1	1.1b
		(3)	
(b)	Differentiate wrt e	M1	2.1
	$\frac{dK}{de} = \frac{1}{2}mu^2(1-5e^4)$	A1	1.1b
	Equate to zero and solve for e	M1	3.1a
	$e^4 = \frac{1}{5} \Rightarrow e = 0.67$ or better	A1	1.1b
		(4)	
(c)	Particle continues to bounce off each wall (indefinitely).	B1	2.4
	Speed of particle decreases oe	B1	2.4
		(2)	
			(9 marks)

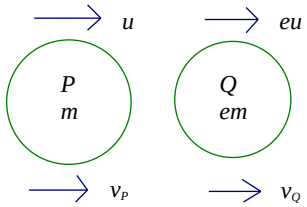
Notes:

2a	B1	Need both for the mark
	M1	Allow terms reversed
	A1	cao
2b	M1	Clear attempt to differentiate their KE loss, in terms of e, wrt e, with powers decreasing by 1

	A1	Correct derivative
		If working from $\frac{1}{2}mu^2\left(1-e^4\right)$ allow M1A0 for a correct argument leading to $e=0$
	M1	Clear attempt to equate to zero
	A1	cao
2c	B1	Any clear equivalent statement
	B1	Any clear equivalent statement. Allow speed tends to 0.

Question	Scheme	Marks	AOs
3(a)	Freewheeling down: Equation of motion down the plane and using the model	M1	3.1b
	$100g\sin\alpha - kV^2 = 0$ $\left(kV^2 = \frac{100g}{35}\right)$	A1	1.1b
	Cycling up: Equation of motion up the plane and using the model	M1	3.1b
	$F - 100g\sin\beta - kV^2 = 0$	A1	1.1b
	Use of $F = \frac{P}{V}$ $\left(\frac{P}{V} = \frac{100g}{70} + \frac{100g}{35}\right)$	M1	3.3
	Solve the problem by solving for P in terms of V and substituting for $\sin\alpha$ and $\sin\beta$	M1	1.1b
	$\left(P = \frac{300gV}{70}\right)$ $P = 42V$	A1	1.1b
		(7)	
(b)	Equation of motion horizontally and using the model	M1	3.4
	$\frac{35V}{U} - kU^2 = 0$	A1	1.1b
	Solve for U in terms of V $\left(\frac{35V}{U} - \frac{100g}{35V^2}U^2 = 0\right)$	M1	3.1b
	$U = 1.1V$ or $U = 1.08V$	A1	1.1b
		(4)	
			(11 marks)
Notes:			

3a	M1	Dimensionally correct. Correct no. of terms, condone sin/cos confusion
	A1	Correct equation
	M1	Dimensionally correct. Correct no. of terms, condone sin/cos confusion
	A1	Correct equation
	B1	Any equivalent form
	M1	Use correct strategy to set up and solve the equations to solve the problem
	A1	cao
3b	M1	Correct no. of terms. Allow $F - kU^2 = 0$ but not $F - kV^2 = 0$
	A1	Correct equation
	M1	Use correct strategy to set up and solve the equations to solve the problem
	A1	Accept 2 sf or 3 sf. $U = \sqrt[3]{\frac{5}{4}}V$ scores 3/4 (depends on the use of g)

Question	Scheme	Marks	AOs
4(a)			
	Conservation of momentum	M1	3.4
	$mu + e^2mu = mv_P + emv_Q$	A1	1.1b
	Newton's Impact Law	M1	3.4
	$e(u - eu) = -v_P + v_Q$	A1	1.1b
	Solve these equations for v_Q	M1	3.1a
	$v_Q = u$ *	A1*	1.1b
		(6)	
(b)	$v_P = u(e^2 - e + 1)$ $\left(= \dfrac{(e^3+1)u}{e+1}\right)$	M1	1.1b
	$= u\left((e - \frac{1}{2})^2 + \frac{3}{4}\right)$	A1	1.1b
	> 0 so P continues to move in the same direction *	A1*	1.1b
		(3)	
		(9)	
(c)	Use impulse-momentum principle	M1	3.4
	$I = em(u - eu)$ or $m(-u(e^2 - e + 1) - (-u))$ $(= (e - e^2)mu)$	A1	1.1b
	$(e - e^2) = \dfrac{2}{9}$ and solve	M1	1.1b
	$e = \dfrac{1}{3}$ or $\dfrac{2}{3}$	A1	1.1b
		(4)	
			(13 marks)

Notes:

4a	M1	Correct no. of terms, allow consistent cancelled m's $\left(u + e^2u = v_P + ev_Q\right)$
	A1	Correct unsimplified equation
	M1	Correct no. of terms, with e on correct side

	A1	Correct unsimplified equation
	M1	Solve for v_Q
	A1*	cao
4b	M1	Solve for v_P
	M1	Completing the square or any other appropriate method
	A1*	Correct conclusion correctly reached
4c	M1	Correct no. of terms, dimensionally correct. Must be subtracting. Needs to be in terms of *e* and *u*.
	A1	Correct unsimplified expressiom (allow -ve answer at this stage)
	M1	Solving an appropriate quadratic equation
	A1	Two correct answers