Pearson Edexcel

Mark Scheme (Results)

Autumn 2020

Pearson Edexcel GCE Further Mathematics
AS Further Mechanics 1 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 $\sqrt{}$ 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 <u>and indicates which response they wish to submit</u>, examiners should mark this response.
If there are several attempts at a question <u>which have not been crossed out</u>, examiners should mark the final answer which is the answer that is the <u>most complete</u>.

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.

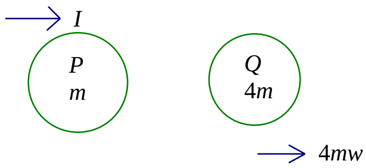
- Marks must be entered in the same order as they appear on the mark scheme.

- 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: $m\times\frac{I}{m}=4mw$	M1	3.1a
	$I=4mw$	A1	1.1b
		(2)	
1b	$e=\frac{w}{4w}=\frac{1}{4}$ *	B1*	3.4
		(1)	
1c	KE Loss = $\frac{1}{2}m(4w)^2-\frac{1}{2}4mw^2$	M1	3.4
	$=6mw^2$	A1	1.1b
		(2)	
			(5 marks)

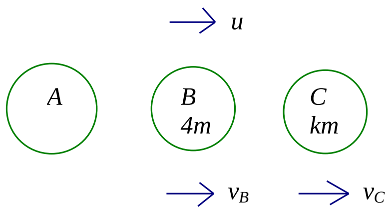
	Notes	
1a	M1	Correct no. of terms, condone extra *g* s, sign errors (must be equation in *I*, *m* and *w* only)
	A1	Correct equation
		Answer not given, so a correct answer with no clear error seen will score M1A1 An answer that relies on an impulse-momentum equation using 4*m* will score M0
1b	B1*	Use of NLR to obtain **given answer**
1c	M1	Allow negative loss
	A1	cao

Question	Scheme	Marks	AOs
2a	$72\text{ km h}^{-1} = 20\text{ m s}^{-1}$	B1	1.1b
		(1)	
2b	Use of $F = \frac{P}{v}$ and using the model	M1	3.4
	Equation of motion and using the model to form equation in c	M1	3.1b
	$\frac{50000}{20} - c \times 20^2 = 1000 \times 2.25 \qquad \left(c = \frac{5}{8}\right)$	A1ft	1.1b
	Equation of motion and using the model	M1	3.1b
	$\frac{50000}{40} - c \times 40^2 = 1000a$	A1ft	1.1b
	Solve for a	M1	1.1b
	$0.25\ (\text{m s}^{-2})$	A1	1.1b
		(7)	
2c	Equation of motion horizontally and using the model	M1	3.1b
	$\frac{50000}{W} - \frac{5}{8}W^2 = 0 \quad (\text{max speed is } W \text{ m s}^{-1})$	A1ft	1.1b
	Solve for W and convert to $\text{km h}^{-1} \qquad (W = 43.088...)$	M1	1.1b
	$V = 155$ (nearest whole number)	A1	1.1b
		(4)	
			(12 marks)

Notes

2a	B1	20 m s^{-1} seen
2b	M1	Follow through the 72 or their v. Allow for 144 or their 144
	M1	Correct no. of terms required
	A1ft	Correct unsimplified equation ft on their 20
	M1	Correct no. of terms required
		Allow the second and third M marks if they have an equation in F rather than P.
	A1ft	Correct equation ft on their 40 and their c
	M1	Complete method to solve for a
	A1	Cao $\left(\text{Accept } \frac{1}{4}\right)$
2c	M1	Equation with correct no. of terms, correct structure and in terms of W only.

	A1ft	Correct equation, ft on their c from part (b).
	M1	Complete method to solve for V (including clear attempt to convert units)
	A1	Cao (The Q asks for a whole number)

Question	Scheme	Marks	AOs
3a			
	Use of CLM	M1	3.1a
	$4mu = 4mv_B + kmv_C$	A1	1.1b
	Use of NLR	M1	3.1a
	$\frac{1}{4}u = -v_B + v_C$	A1	1.1b
	Solve for v_B	M1	1.1b
	$v_B = \frac{u(16-k)}{4(k+4)}$ $\left(v_C = \frac{5u}{k+4}\right)$	A1	1.1b
	Use of $v_B \geq 0$ and solve for k	M1	3.4
	$(0 <)\, k \leq 16$	A1	1.1b
	Alternative for last 4 marks		
	Solve for v_B in terms of v_C only	M1	
	$v_B = \frac{(16-k)v_C}{20}$	A1	
	Use of $v_B \geq 0$ and $v_C > 0$ to solve for k	M1	
	$(0 <)\, k \leq 16$	A1	
		(8)	
3b	Impulse-momentum equation	M1	3.1a
	$-3mu = 4m(v_B - u)$ $\left(v_B = \frac{u}{4}\right)$ or $3mu = kmv_C$	A1	1.1b
	Complete method to solve for k	M1	1.1b
	$k = 6$	A1	2.2a
		(4)	
		(12 marks)	

Notes

3a	M1	Correct no. of terms, condone extra *g* s, sign errors
	A1	Correct equation
	M1	*e* must be on correct side
	A1	Correct equation
	M1	Complete method to solve for v_B (or a multiple of v_B)
	A1	Correct expression for *their* v_B or a multiple of *their* v_B
	M1	Use of appropriate inequality, allow strict inequality for method mark
	A1	Cao LHS not needed, but if there it must be correct.
3b	M1	Correct no. of terms, condone sign errors, but must be subtracting momentum terms
	A1	Correct equation
	M1	Eliminate and solve for *k*
	A1	$k = 6$

Question	Scheme	Marks	AOs
4a	$\frac{1}{2}mgH$	B1	1.1b
	$\frac{1}{2}m(8gH - v^2)$	B1	1.1b
	Apply the work-energy principle	M1	3.3
	$\frac{1}{2}mgH = \frac{1}{2}m(8gH - v^2) - mgH$	A1	1.1b
	$v = \sqrt{5gH}$	A1	1.1b
		(5)	
4b	Use NLR to find rebound speed: $\frac{1}{2}\sqrt{5gH}$	M1	3.4
	Apply the work-energy principle or *suvat* with $a = \frac{1}{2}g$	M1	3.3
	$\frac{1}{2}mgH = mgH - \frac{1}{2}m(v_1^2 - \frac{1}{4}\times 5gH)$ or $(v_1)^2 = \frac{5gH}{4} + 2\times\frac{g}{2}\times H$	A1ft A1	1.1b 1.1b
	$v_1 = \frac{3}{2}\sqrt{gH}$	A1	2.2a
		(5)	
4c	Since $e < 1$, ball loses energy in its collision with the ceiling.	B1	2.4
		(1)	
		(11 marks)	

Notes

4a	B1	Work done against resistance (allow -ve) Can be implied by use of $\frac{3}{2}mgH$ (work done against resistance + work done against weight)
	B1	KE loss (allow -ve)
	M1	Correct no. of terms, dimensionally correct. Condone sign errors.
	A1	Correct unsimplified equation
	A1	Correct answer (any equivalent but must be in terms of g and H) Accept $2.2\sqrt{gH}$ or better
4b	M1	Use of NLR
	M1	Correct no. of terms, dimensionally correct
	A1ft	Correct equation with at most one error ft on their answer to (a)
		M1A1ft is available to a candidate who has not scored the first M1

	A1	Correct equation (no ft)
	A1	Correct answer (any equivalent but must be in terms of g and H)
4c	B1	Clear explanation
		Need to identify that the loss of KE occurs in the impact with the ceiling. Do not insist on seeing $e < 1$ or equivalent. If they include incorrect additional statements then B0

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