Mark Scheme

Summer 2023

Pearson Edexcel GCE

Advanced Subsiduary Level

Further Mathematics (8FM0)

Paper 25 : 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.

Question	Scheme	Marks	AOs
1(a)	$2u \rightarrow \quad \leftarrow u$ $\frac{9mu}{2} \longleftarrow (P)\ 3m \quad (Q)2m \longrightarrow \frac{9mu}{2}$ $\rightarrow v \quad \rightarrow y$		
	Use of Impulse-momentum principle for P	M1	3.1a
	$-\frac{9mu}{2} = 3m(v-2u)$	A1	1.1b
	$v = \frac{u}{2}$	A1	1.1b
		(3)	
1(b)	Use of Impulse-momentum principle for Q or CLM	M1	3.4
	$\frac{9mu}{2} = 2m(y--u)$ **OR** $3m\times 2u - 2mu = 3m\times\frac{u}{2} + 2my$ $\left(y = \frac{5u}{4}\right)$	A1	1.1b
	Newton's Experimental Law	M1	3.4
	$e = \frac{\frac{5u}{4} - \frac{u}{2}}{2u+u}$	A1	1.1b
	$e = \frac{1}{4}$ oe	A1	1.1b
		(5)	
			(8 marks)

Notes:

1a	M1	Use of Impulse-momentum principle for P, condone sign errors but M0 if dimensionally incorrect e.g. if m missing or g included.
	A1	Correct unsimplified equation (may have $-v$)
	A1	cao (must be positive)
1b	M1	Use of Impulse-momentum principle for Q, must be using $2m$, condone sign errors but M0 if dimensionally incorrect e.g. g included Or use of CLM, condone sign errors and consistent omission of m's or consistent extra g's, with their v. Must be using correct masses on all four terms.
	A1	Correct unsimplified equation
	M1	Use of NEL with their v and their y, condone sign errors but M0 if ratio for e is inverted

	A1	Correct unsimplified equation in u and e only
	A1	cao

Question	Scheme	Marks	AOs
2(a)	$F = \dfrac{60000}{v}$	M1	3.3
	Equation of motion parallel to the road, $F - 37.5v = 0$	M1	3.1b
	$\dfrac{60000}{v} - 37.5v = 0$ (Allow v replaced by U)	A1	1.1b
	$U = 144$	A1	1.1b
		(4)	
2(b)	Equation of motion parallel to the slope.	M1	3.1b
	$F - 37.5V - 750g\sin\alpha = 750\times 2$	A1	1.1b
	$\dfrac{60000}{V} - 37.5V - 750g\sin\alpha = 750\times 2$	A1	1.1b
	$V = 20$	A1	1.1b
		(4)	
			(8 marks)

Notes:		
2a	M1	Use of $P = Fv$ with $P = 60$ or 60000. Allow U instead of v. **N.B.** Allow if seen in (b).
	M1	Equation of motion with correct no. of terms, condone sign errors, and allow U instead of v. Neither v nor F need to be substituted. **N.B.** M0 for $60000 - 37.5v = 0$
	A1	Correct unsimplified equation in v only, seen or implied. A0 if they replace only one of the v's by U
	A1	cao
2b	M1	Equation of motion with correct no. of terms, condone sign errors, and sin/cos confusion (M0 if they use $v = 40$)
	A1	Correct equation with at most 1 error, $\sin\alpha$ does not need to be substituted
	A1	Correct equation in V only, $\sin\alpha$ does not need to be substituted
	A1	cao

Question	Scheme	Marks	AOs
3(a)	Attempt at use of conservation of energy principle	M1	3.4
	$\frac{1}{2}m\times 25^2-\frac{1}{2}mU^2=mg\times 2.5$	A1	1.1b
		A1	1.1b
	$U = 24$	A1	1.1b
	ALT 1: $\frac{1}{2}m\times 25^2=mgh$ $0=U^2-2g(\frac{625}{2g}-2.5)$ $U=24$ ALT 2: $\frac{1}{2}m\times U^2=mgd$ $25^2=2g(\frac{U^2}{2g}+2.5)$ M1A2 for a *complete* method (-1 eeoo) $U=24$ ALT 3: $\frac{1}{2}m\times U^2=mgd$ $\frac{1}{2}m\times 25^2=mg(\frac{U^2}{2g}+2.5)$ $U=24$		
		(4)	
3(b)	The value of U would be larger	B1	3.5a
		(1)	
3(c)	WD against resistance = $2000\times 0.01d$	M1	3.4
	Use of work-energy principle	M1	3.1b
	$2000\times 0.01d=0.5g\times 0.01d+\frac{1}{2}\times 0.5\times 25^2$	A1	1.1b
		A1	1.1b
	d = 7.83 (3 sf) **N.B.** If PE term is omitted, d = 7.8152 and scores max M1M0A0A0A0	A1	1.1b
		(5)	
			(10 marks)

Notes:

3a	M1	Correct no. of terms (two KE and one PE), dimensionally correct equation, condone sign errors m does not need to be substituted and allow cancelled m's. N.B. M0 if clearly using $v^2=u^2+2as$ for the whole motion. M0 if they use $0.5g$ x $(2.5 + 0.01d)$ since extra term
	A1	Correct equation in U only with at most one error

	A1	Correct equation in U only
	A1	cao
3b	B1	cao
3c	M1	Use of work = force x distance (allow if 0.01 is omitted)
	M1	Correct no. of terms (one KE, one PE, one Work Done), dimensionally correct equation N.B. M0 if not using work-energy principle
	A1	Correct equation in d only with at most one error (omission of 0.01 twice is one error)
	A1	Correct equation in d only
	A1	cao

Question	Scheme	Marks	AOs
4(a)	$u \rightarrow \quad \leftarrow 0$ $(P)\ m \quad (Q)2m$. $\longleftarrow \quad \longrightarrow$ $v_P \quad v_Q$		
	Use of CLM	M1	3.4
	$mu = -mv_P + 2mv_Q$	A1	1.1b
	Use of NEL	M1	3.4
	$eu = v_P + v_Q$	A1	1.1b
	Solve for v_Q	M1	1.1b
	$v_Q = \frac{u(1+e)}{3}$* Allow $\frac{u(e+1)}{3}$	A1*	2.1
		(6)	
4(b)	$e > \frac{1}{2} \Rightarrow \frac{u(1+e)}{3} > \frac{1}{2}u$ Allow this argument reversed.	M1	3.1b
	Hence collision between Q and R will occur	A1	1.1b
		(2)	
4(c)	$v_P = \frac{u(2e-1)}{3}$	M1	3.1a
	$e > \frac{1}{2} \Rightarrow v_P > 0$ so P moves in the opposite direction to its original direction oe e.g. direction (motion) of P is reversed, opposite direction to Q A0 for any of: direction changes, P moves away from Q, goes left, P will travel in the negative direction, P moves backwards	A1	2.4
	ALT: $e > \frac{1}{2} \Rightarrow v_Q > \frac{1}{2}u$ oe Since $v_P = 2v_Q - u, v_P > 0$	M1	
	so P moves in the opposite direction to its original direction oe e.g. direction (motion) of P is reversed, opposite direction to Q	A1	
		(2)	
	Correct expression using their v_P	M1	3.1a

4(d)	$\frac{1}{2}mu^2 - \frac{1}{2}m\left[\frac{u(2e-1)}{3}\right]^2 - \frac{1}{2}2m\left[\frac{u(e+1)}{3}\right]^2$	A1	1.1b
	$= \frac{1}{3}mu^2 - \frac{1}{3}mu^2e^2 = \frac{1}{3}mu^2(1-e^2)$	A1	1.1b
		(3)	
4(e)	The answer for part (d) should equal 0 when $e = 1$.	B1	2.4
		(1)	
			(14 marks)

Notes:

4a	M1	Correct no. of terms with correct pairings, condone sign errors, allow consistently cancelled *m*'s or extra *g*'s. M0 if they assume the same speeds
	A1	Correct equation
	M1	Correct no. of terms, condone sign errors. M0 if *e* on the wrong side of the equation
	A1	Correct equation consistent with their CLM equation
	M1	Solve for v_Q
	A1*	Correct given answer correctly obtained
4b	M1	Use of $e > \frac{1}{2}$ in answer to (a). Allow M1 for: if $e = ½$, $v_Q = \frac{1}{2}u$ hence (if $e > \frac{1}{2}$), $v_Q > \frac{1}{2}u$,
	A1	cso
4c	M1	Finds v_P in terms of *u* and *e* only using one of their equations
	A1	cso
4d	M1	Correct no. of terms, dimensionally correct. Allow if *m* and 2*m* are swapped or *m* used for mass of *Q* but otherwise correct. Allow an expression for the KE gain.
	A1	Correct unsimplified expression
	A1	Any correct simplified two term expression, not necessarily factorised.
4e	B1	Correct explanation. This can be scored after an incorrect answer to (d). Need to say that when $e = 1$, KE change = 0 Not enough to say KE Before = KE After

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