Mark Scheme (Results)

Summer 2019

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 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.

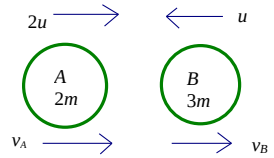
- Misreads – if a misread does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, bearing in mind that after a misread, the subsequent A marks affected are treated as A ft

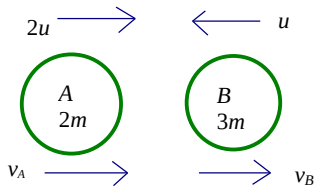
- Mechanics Abbreviations
  M(A) Taking moments about A
  N2L Newton's Second Law (Equation of Motion)
  NEL Newton's Experimental Law (Newton's Law of Impact)
  HL Hooke's Law
  SHM Simple harmonic motion
  PCLM Principle of conservation of linear momentum
  RHS, LHS Right hand side, left hand side

Question	Scheme	Marks	AOs
1(a)	Equation of motion parallel to the road with $a = 0$ and using the model	M1	3.3
	$F - 16000 = 0$	A1	1.1b
	$P = 16\,000 \times 25$	M1	3.4
	$= 400\,000 = 400$ kW *	A1*	1.1b
		(4)	
(b)	Use of $\frac{400\,000}{V}$	M1	3.3
	Equation of motion parallel to the road and using the refined model	M1	3.4
	$\frac{400\,000}{V} - 640V = 16000 \times 2.1$	A1	1.1b
	$2V^2 + 105V - 1250 = 0 \quad \left(640V^2 + 33600V - 400000 = 0\right)$	A1	1.1b
	Solve for V	M1	1.1b
	$V = 10$ (i.e. speed is 10 m s^{-1})	A1	1.1b
		(6)	
			(10 marks)

Notes

(a)	M1	Correct no. of terms with $a = 0$, condone sign errors Given answer, so step must be seen, but allow if in verbal form or on a diagram.
	A1	Correct equation
	M1	Use of $P = Fv$ Independent mark - could be the first mark seen
	A1*	Obtain **given answer** from correct working
(b)	M1	Use of $P = Fv$
	M1	Correct no. of terms, condone sign errors. Dimensionally correct
	A1	Correct unsimplified equation
	A1	Correct 3 term quadratic
	M1	For solving a 3 term quadratic – this mark can be implied by a correct value of V but otherwise can only be earned for evidence of an explicit method being used.
	A1	$V = 10$ only

Question	Scheme	Marks	AOs
2 (a)	Using the Impulse-momentum principle for B	M1	3.1a
	$5mu == 3m(v_B - -u)$	A1	1.1b
	$v_B = \frac{2u}{3}$	A1	1.1b
	Use of conservation of momentum	M1	3.1a
	$4mu - 3mu = 2mv_A + 3mv_B \left(= 2mv_A + 3m.\frac{2u}{3} \right)$	A1ft	1.1b
	$v_A = -\frac{u}{2}$	A1	1.1b
	Use of NLR	M1	3.4
	$e = \frac{v_B - v_A}{2u + u} \left(= \frac{\frac{u}{2} + \frac{2u}{3}}{2u + u} \right)$	A1ft	1.1b
	$e = \frac{7}{18} = 0.39$ or better	A1	1.1b
			
		(9)	
(b)	KE Loss = Initial KE – Final KE	M1	2.1
	$= \frac{1}{2}.2m(2u)^2 + \frac{1}{2}.3mu^2 - \left(\frac{1}{2}.2m\left(-\frac{u}{2} \right)^2 + \frac{1}{2}.3m\left(\frac{2u}{3} \right)^2 \right)$	A1ft	1.1b
		A1ft	1.1b
	$= \frac{55mu^2}{12}$	A1	1.1b
		(4)	
			(13 marks)

Notes		
(a)	M1	Correct no. of terms and dimensionally correct but condone sign errors but must be a difference of momenta
	A1	Correct unsimplified equation
	A1	Correct appropriate velocity
	M1	Use of CLM with correct no. of terms and dimensionally correct but condone sign errors **Alternative**: Use Impulse - momentum for A
	A1ft	Correct unsimplified CLM equation **Or:** $-5mu = 2m(v_A - 2u)$
	A1	Correct speed
	M1	Use of NLR with e on the correct side
	A1ft	Correct unsimplified equation
	A1	Correct answer
ALT		 Could find v_A before v_B : M1A1A1 for first velocity, M1A1A1 for second M1A1A1 for e found correctly
		Candidates are approaching this in many different ways. They need - two of momentum impulse equation for each particle and CLM - impact law M1A1 for each correct equation (in the order seen) Of the remaining 3 A marks, A1 for a correct expression for v_A or v_B A1 for a correct expression in e A1 for the correct answer

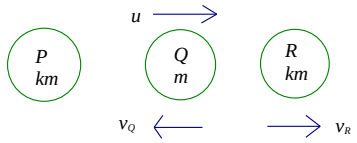
Notes Continued		
e.g	M1A1	CLM: $4mu - 3mu = 2mv_A + 3mv_B$
	M1A1	Impact: $v_B - v_A = 3ue$
	A1	$v_B = \frac{u}{5}(1+6e)$ *or* $v_A = \frac{u}{5}(1-9e)$
	M1A1	$5mu = 3m\left(v_B - (-u)\right)$ $\left(= 3m\left(\frac{u}{5}(1+6e)+u\right)\right)$ Or $-5mu = 2m(v_A - 2u)$ $\left(= 2m\left(\frac{u}{5}(1-9e)-2u\right)\right)$
	A1	$5 = 3\left(\frac{1}{5}(1+6e)+1\right)$ or $-5 = 2\left(\frac{1}{5}(1-9e)-2\right)$
	A1	$e = \frac{7}{18} = 0.39$ or better
(b)	M1	Correct no. of terms and must be a difference. Must be dimensionally correct at the point when they state their expression for the loss (change) in KE
	A1ft	Unsimplified expression in u with at most 1 error, ft on their speeds from (a)
	A1ft	Correct unsimplified expression in u. (These first 3 marks can be scored for a correct loss or gain in KE), ft on their speeds from (a)
	A1	cso Accept $4.58mu^2$ or $4.6mu^2$

Question	Scheme	Marks	AOs
3	Work done $= \frac{1}{5}mg \times 8 \quad (15.68m)$	B1	3.4
	PE Loss = $8mg\sin\alpha \quad (47.04m)$	B1	1.1b
	KE Gain = Difference of two KE terms	M1	3.4
	$= \frac{1}{2}mv^2 - \frac{1}{2}m5^2$	A1	1.1b
	Work done against friction = PE Loss – KE Gain	M1	2.1
	$\frac{1}{5}mg \times 8 = 8mg\sin\alpha - \left(\frac{1}{2}mv^2 - \frac{1}{2}m5^2\right)$	A1	1.1b
	v = 9.4 or 9.37 (m s^{-1})	A1	1.1b
		(7)	
			(7 marks)

Notes

The question instructs candidates to use the work-energy principle, so *suvat* methods will not score the second M1.

B1	Work done against friction seen or implied
B1	PE loss seen or implied
	NB: B1B1 for $\left(\frac{3}{5}mg - \frac{1}{5}mg\right) \times 8 \quad \left(= \frac{16}{5}mg\right)$
M1	Difference in two KE terms seen or implied (allow KE loss)
A1	Correct unsimplified expression. Allow $\pm$
M1	Work-energy equation with all terms. Must be dimensionally correct but condone sign errors
A1	Correct unsimplified equation
A1	2 sf or 3 sf (after use of g = 9.8)

Question	Scheme	Marks	AOs
4(a)			
	Use of conservation of momentum	M1	3.1a
	$mu = -mv_Q + kmv_R$	A1	1.1b
	Use of NLR	M1	3.4
	$eu = v_Q + v_R$	A1	1.1b
	Using correct strategy to solve problem by finding v_Q	M1	3.1a
	$v_Q = \frac{u(ke-1)}{k+1}$ or $v_Q = \frac{v_R(ke-1)}{1+e}$	A1	1.1b
	For second collision, $v_Q > 0$	M1	3.1a
	$\frac{u(ke-1)}{k+1} > 0$	M1	1.1b
	$k > \frac{1}{e}$	A1	1.1b
		(9)	
(b)	$\frac{u(ke-1)^2}{(k+1)^2}$	B1	2.2a
		(1)	
			(10 marks)

Notes		
(a)	M1	Correct no. of terms and dimensionally correct but condone sign errors
	A1	Correct equation
	M1	Use of NLR with *e* on the correct side
	A1	Correct equation (any equivalent form) Signs consistent with CLM equation
	M1	Solving for v_Q - complete correct strategy (i.e. correct use of CLM and of NLR)
	A1	Correct expression for their v_Q Can be implied by a correct multiple of v_Q
	M1	Use of appropriate condition for their v_Q
	M1	Complete correct strategy to find values for *k* (i.e. set up and solve inequality)
	A1	cso
(b)	B1	Or equivalent cao

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