

Mark Scheme

Summer 2023

Pearson Edexcel GCE

In AS Level Mathematics (8MA0)

Paper 02 Mechanics

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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 30.

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. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

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)	Because the distances travelled or displacements are equal oe. If they mention the times are the same as well, ignore it.	B1	2.4
		(1)	
1(b)	0.8 or 4/5 ($\mathrm{m\,s^{-2}}$)	B1	1.1b
		(1)	
1(c)	$\frac{1}{2}\times 5\times 4+(4\times 22.5)$ **OR** $\frac{1}{2}(27.5+22.5)\times 4$ **OR** $27.5\times 4-\frac{1}{2}\times 5\times 4$	M1	3.1b
	100 (m)	A1	1.1b
		(2)	
1(d)	Total area under graph = their answer for part (c)	M1	3.1b
	$\frac{1}{2}X\times X+X(27.5-X)=100$	A1**ft**	1.1b
	OR $\frac{1}{2}(27.5+27.5-X)\times X=100$ **OR** $27.5X-\frac{1}{2}X^2=100$	A1**ft**	1.1b
	X = 3.92 to 3sf	A1	1.1b
		(4)	
			(8 marks)

Notes:

1a	B1	Must mention distances being equal specifically.
1b	B1	cao
1c	M1	Clear attempt to find the **total** area under the *P* graph, with the correct structure i.e. (triangle + rectangle) **OR** trapezium **OR** (rectangle – triangle); must see use of ½ where appropriate. **OR** they may use *suvat* to find the distance covered by *P* in one or more of the sections. **N.B**. M0 for use of a single *suvat* formula for the whole motion
	A1	cao
1d	M1	Clear attempt to equate the total area under the *S* graph, with the correct structure, i.e. (triangle + rectangle) **OR** trapezium **OR** (rectangle – triangle), must see use of ½ where appropriate, to their answer for (c) to give a <u>quadratic equation in *X* only</u> **N.B.** they may use *suvat* to find the distance covered by *S* in one or more of the sections. **N.B**. M0 for use of a single *suvat* formula for the whole motion
	A1**ft**	Correct unsimplified quadratic equation in *X* only with at most one error, follow their answer for (c)
	A1**ft**	Correct unsimplified quadratic equation in *X* only, follow their answer for (c)
	A1	cao

If they use *g* = 9.81 or 10 in this question, penalise once for whole question.

Question	Scheme	Marks	AOs
2(a)	Attempt to find the displacement after 10 s	M1	3.1b
	$39.2\times10-\frac{1}{2}g\times10^2$ **OR** $-39.2\times10+\frac{1}{2}g\times10^2$	A1	1.1b
	98 (m) (must be positive)	A1	1.1b
		(3)	
2(b)	Complete method to find either half the time or the full time	M1	3.1b
	Correct equation e.g. $0=24.5-gt$ **OR** $-24.5=24.5-gt$	A1	1.1b
	5 (s)	A1	1.1b
		(3)	
2(c)	e.g. (include) air resistance	B1	3.5c
		(1)	
			(7 marks)

Notes:		**Penalise explicit use of *g* = 9.81 or 10 once for the whole question the first time it occurs.**
2a	M1	Complete method, using $s=ut+\frac{1}{2}at^2$ or possibly $s=vt-\frac{1}{2}at^2$ with the motion reversed, or an 'up and down' method i.e an appropriate equation for the motion from *O* to the top **AND** an appropriate equation from the top down to the ground **AND** combining to give the total distance
	A1	Correct expression (s) **N.B.** If using an 'up and down method', this mark is for **all** the intermediate values: Distance up = 78.4, Time up = 4, time down = 6, distance down = 176.4 **AND** combining correctly i.e. (176.4 – 78.4) or (78.4 –176.4) These are the values for *g* = 9.8
	A1	cao
2b	M1	Complete method to find half the time or the full time. Allow inequalities. e.g. for half the time, they may find *t* = 4 and *t* = 1.5 and subtract e.g. for the full time, they may find *t* = 6.5 and *t* = 1.5 and subtract
	A1	Correct equation or equations if they are using more than one.
	A1	cao
2c	B1	e.g. (use) a more accurate value of *g*, (include) spin of the stone, (include)shape of the stone, (include) size of the stone, (include) wind effects , rotation B0 if any incorrect extras are included e.g. the mass or weight of the stone DO NOT ALLOW NEGATIVES OF THESE e.g there is no air resistance

Question	Scheme	Marks	AOs
3(a)	$15-3^2-2\times3=0$ *	B1*	1.1b
		(1)	
3(b)	Differentiate *v* wrt *t*	M1	2.1
	$-2t-2$	A1	1.1b
	8 ($\mathrm{m\,s^{-2}}$)	A1	1.1b
		(3)	
3(c)	Integrate *v* w.r.t. *t*	M1	1.1b
	$15t-\frac{1}{3}t^3-t^2$	A1	1.1b
	Total distance = $\left[15t-\frac{1}{3}t^3-t^2\right]_0^3-\left[15t-\frac{1}{3}t^3-t^2\right]_3^4$ **OR** $s_3+(s_3-s_4)$ where s_3 means the value of their integral when $t = 3$. **N.B.** Allow the negative of this.	M1	3.1a
	$\frac{94}{3}$ (m)	A1	1.1b
		(4)	
			(8 marks)

Notes:		
3a	B1*	Correct expression, correctly evaluated to give 0 **OR** $0=15-t^2-2t$ $t = 3$
3b	M1	Differentiate *v*, with at least two powers decreasing by 1
	A1	Correct expression
	A1	cao (must be positive)
		N.B. If they give 8 as their answer, without any working, this can score all 3 marks.
3c	M1	Integrate *v*, with at least two powers increasing by 1 (allow if only two terms integrated) .
	A1	Correct expression. Ignore (+ *C*)
	M1	Complete method to find the total distance or displacement
	A1	Accept 31(m) or better, must be positive
		N.B. If the indefinite integral ($15t-\frac{1}{3}t^3-t^2$) is never seen, they score nothing, even if the correct answer appears, as this indicates they have used a calculator to do the whole question.

Question	Scheme	Marks	AOs
4(a)	Equation of motion for the car	M1	3.3
	$7400 - 2R - 2400 = 1200a$	A1	1.1b
	Equation of motion for the trailer	M1	3.4
	$2400 - R = 400a$	A1	1.1b
	$a = 0.5$	A1	1.1b
		(5)	
	N.B. Either equation could be replaced by: Equation of motion for the whole system $7400 - 3R = 1600a$		
4(b)	The value of a_1 would be less than the value of a. Allow 'a_1 would be slower than a', **N.B.** Allow 'it would be less than a'	B1	3.5a
		(1)	
4(c)	The resistance won't be constant or just 'it won't be constant.' Allow the negative also: The resistance is constant or just 'it is constant' B0 for 'it doesn't take account of air resistance'	B1	3.5b
		(1)	
			(7 marks)

Notes:		
4a		**N.B. When entering marks on ePEN for the two equations of motion, enter them in the order in which they appear on the script.** For any equation of motion, use the mass in the '*ma*' term to determine to which part of the system it relates.
	M1	Correct no.of terms and condone sign errors, with the driving force as 7400 (when appropriate) and the tension as 2400.
	A1	Correct equation
	M1	Correct no.of terms and condone sign errors, with the driving force as 7400 (when appropriate) and the tension as 2400.
	A1	Correct equation
	A1	cao
4b	B1	cao
4c	B1	B0 if any incorrect extras are given or for an incorrect statement

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