Pearson Edexcel

Mark Scheme

Mock Set 3

Pearson Edexcel GCE
In Mathematics (9MA0)
Paper 32 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 50.

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)

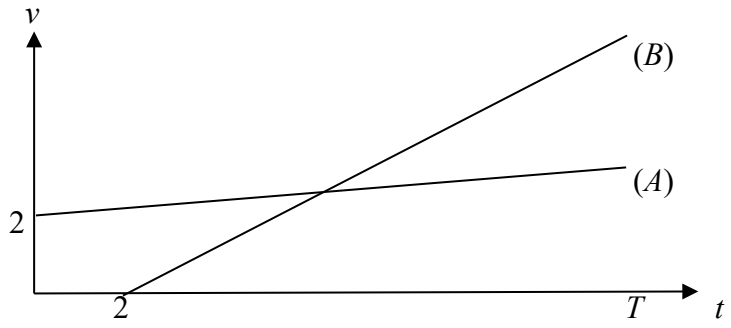
  NEL Newton's Experimental Law (Newton's Law of Impact)

  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)		B1 (A) B1 (B)	3.4 3.4
		(2)	
1(b)	Lines must cross before time T seconds, since area under each graph must be equal.	B1	2.4
		(1)	
1(c)	Use equal speeds and *suvat* to set up an equation in t only: $2+2t=6(t-2)$	M1	3.1b
	$t=3.5$ oe	A1	1.1b
		(2)	
1(d)	Use equal areas and *suvat* to set up an equation in T only	M1	2.1
	$\frac{1}{2}T(2+(2+2T))=\frac{1}{2}(T-2)6(T-2)$ **OR**: $2T+\frac{1}{2}T\times 2T=\frac{1}{2}(T-2)6(T-2)$	A1	1.1b
	$T=6$ only	A1	1.1b
	Solve the problem by substituting for T in either expression for distance	M1	3.1b
	48 (m)	A1	1.1b
		(5)	
			(10 marks)

Notes:		
1a	B1	Correct graph for A including 2 and T
	B1	Correct graph for B including 2, intersecting the graph for A.
1b	B1	Any equivalent appropriate statement
1c	M1	Complete method to give equation in t only
	A1	cao

1d	M1	Complete method using either areas with correct structure or *suvat* to give a quadratic in T
	A1	Correct unsimplified equation
	A1	cao (A0 if they include $T = 1$)
	M1	Must be substituting into a quadratic expression
	A1	cao

Question	Scheme	Marks	AOs

2(a)	$(3t-1)\mathbf{i}+2\mathbf{j}=0.5\mathbf{a}$	M1	3.1a
	Integrate their **a** wrt t	M1	2.1
	$(3t^2-2t)\mathbf{i}+4t\mathbf{j}$ (+**C**)	A1	1.1b
	Find **C** and substitute in $t = 2$	M1	1.1b
	$9\mathbf{i}+7\mathbf{j}$ (m s^{-1})	A1	1.1b
		(5)	
2(b)	Integrate their **v** wrt t	M1	2.1
	$(t^3-t^2+t)\mathbf{i}+(2t^2-t)\mathbf{j}$ (+**D**)	A1**ft**	1.1b
	Solve problem by putting $t = 2$ and using Pythagoras, with square root	M1	3.1a
	$\sqrt{72}$ oe, 8.5 or better (m)	A1	1.1b
		(4)	
			(9 marks)

Notes: Accept column vectors throughout

2a	M1	Use of **F** = m**a**, with $m = 0.5$ seen or implied
	M1	At least two powers increasing by 1
	A1	Correct vector expression
	M1	Use boundary condition to find **C** and sub in $t = 2$
	A1	cao
2b	M1	At least two powers increasing by 1
	A1**ft**	Follow their **v**
	M1	Putting $t = 2$ into their vector displacement expression and finding the magnitude
	A1	cao

Question	Scheme	Marks	AOs

3(a)	Resolve perpendicular to the plane : $R = mg\cos\alpha$	M1	3.4
	$R = \frac{3}{5}mg$	A1	1.1b
		(2)	
3(b)(i)	Use the model to set up equation of motion for A	M1	3.3
	$2mg - \frac{7mg}{5} = 2ma$	A1	1.1b
(ii)	$a = \frac{3g}{10}$	A1	1.1b
		(3)	
3(c)	Use the model to set up equation of motion for B	M1	3.4
	$\frac{7mg}{5} - mg\sin\alpha - F = ma$	A1	1.1b
	$F = \mu R$	B1	1.2
	Solve problem by solving equations for μ	M1	3.1a
	$\mu = \frac{1}{2}$	A1	1.1b
		(5)	
3(d)	The tension would not be constant oe	B1	3.5b
		(1)	
			(11 marks)

Notes:		
3a	M1	Correct no. of terms and allow sin/cos confusion
	A1	cao
3b (i)	M1	Correct no. of terms, allow sin/cos confusion and sign errors. T does not need to be substituted.
	A1	Correct unsimplified equation
(ii)	A1	cao
3c	M1	Correct no. of terms, allow sin/cos confusion and sign errors T does not need to be substituted.
	A1	Correct equation
	B1	With their R
	M1	Must be a numerical value and have come from the use of two equations of motion
	A1	cao

3d	B1	The inclusion of any incorrect statements scores B0

Question	Scheme	Marks	AOs
4(a)	Horizontal motion: $64 = 4UT$	M1	3.3
	$UT = 16$*	A1*	1.1b
		(2)	
4(b)	Vertical motion: use of $s = ut + \frac{1}{2}at^2$	M1	3.4
	$-9.6 = UT - 4.9T^2$	A1	1.1b
	Solve the two equations for U	M1	2.1
	$U = 7$	A1	1.1b
	Use Pythagoras to solve the problem: $V = \sqrt{(4U)^2 + U^2}$	M1	3.1b
	$V = 29$ or 28.9	A1	1.1b
		(6)	
4(c)	Any two of : allow for wind effects, spin of the ball, use a more accurate value for g	B1	3.5c
		B1	3.5c
		(2)	
			(10 marks)

4a	M1	Complete method to obtain an equation in U and T for horizontal motion, condone sign errors
	A1*	Correct equation, correctly obtained.
4b	M1	Complete method to obtain an equation in U and T for vertical motion, condone sign errors
	A1	Correct equation, correctly obtained.
	M1	Must be solving 2 equations
	A1	cao
	M1	U does not need to be substituted
	A1	cao (no surds)
4c	B1	One correct statement and at most one incorrect statement
	B1	Two correct statements and no incorrect statements

Question	Scheme	Marks	AOs
5(a)	Moments about B	M1	3.3
	$W \times \frac{2a}{3} = Ta\sin\alpha$	A1	1.1b
	$T = \frac{5}{6}W$ *	A1*	2.2a
		(3)	
5(b)	Moments about A $\left(aS\sin\beta = \frac{1}{3}aW\right)$ OR Moments about G $\left(\frac{2}{3}aS\sin\beta = \frac{1}{3}aT\sin\alpha\right)$ OR Resolve vertically $(T\sin\alpha + S\sin\beta = W)$	M1	3.4
	$S\sin\beta = \frac{1}{3}W$ *	A1*	2.2a
		(2)	
5(c)	Resolve horizontally	M1	3.3
	$S\cos\beta = T\cos\alpha$	A1	1.1b
	$S\cos\beta = \frac{1}{2}W$	A1	1.1b
	$S = \sqrt{\left(\frac{1}{2}W\right)^2 + \left(\frac{1}{3}W\right)^2}$	M1	2.1
	$S = \frac{\sqrt{13}}{6}W$ oe, $0.6W$ or better	A1	1.1b
		(5)	
			(10 marks)

Notes:

5a	M1	Correct no. of terms, dimensionally correct, condone sin/cos confusion and sign errors
	A1	Correct equation
	A1*	Given answer correctly obtained
5b	M1	Correct no. of terms, dimensionally correct, condone sin/cos confusion
	A1*	Given answer correctly obtained
5c	M1	Correct no. of terms, dimensionally correct, condone sin/cos confusion and sign errors
	A1	Correct equation

	A1	Correct equation in S, W and β only
	M1	Complete method to find S in terms of W only e.g. Divide to obtain $\tan\beta = \frac{2}{3}$ and use it to find S
	A1	cao

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