Pearson Edexcel

Mark Scheme

Mock Set 4

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)	$(-\mathbf{i}+4\mathbf{j})+3(3\mathbf{i}-2\mathbf{j})$	M1	2.1
	$=(8\mathbf{i}-2\mathbf{j})$	A1	1.1b
	$\sqrt{8^2+(-2)^2}$	M1	3.1a
	$=\sqrt{68}$ (m s^{-1})	A1	1.1b
		(4)	
1(b)	Use of $\mathbf{s}=\mathbf{u}t+\frac{1}{2}\mathbf{a}t^2$ with $t=2$	M1	2.1
	$2(-\mathbf{i}+4\mathbf{j})+\frac{1}{2}(3\mathbf{i}-2\mathbf{j})\times 2^2$	A1	1.1b
	$(9\mathbf{i}+2\mathbf{j})$ (m)	A1ft	3.1a
		(3)	
			(7 marks)

Notes: Accept column vectors throughout		
1a	M1	Use of $\mathbf{v}=\mathbf{u}+\mathbf{a}t$ with $t=3$.
	A1	cao
	M1	Use of Pythagoras with square root.
	A1	Any equivalent surd.
1b	M1	Any other complete method to find the displacement vector.
	A1	Correct unsimplified expression.
	A1ft	Their displacement vector + $(5\mathbf{i}-2\mathbf{j})$

Question	Scheme	Marks	AOs
2(a)	Integrate **a** wrt t	M1	3.1a
	$\left(t-\frac{3}{2}t^2\right)\mathbf{i}+\left(\frac{2}{3}t^3-t^2\right)\mathbf{j}\ (+\mathbf{C})$	A1	1.1b
	$\left(t-\frac{3}{2}t^2+3\right)\mathbf{i}+\left(\frac{2}{3}t^3-t^2-2\right)\mathbf{j}\quad\left(\text{m s}^{-1}\right)$	A1	1.1b
		(3)	
2(b)	$1-3t=2t^2-2t$ oe	M1	2.1
	$t=\frac{1}{2}$	A1	1.1b
	Integrate their **v** wrt t	M1	3.4
	$\left(\frac{1}{2}t^2-\frac{1}{2}t^3+3t\right)\mathbf{i}+\left(\frac{1}{6}t^4-\frac{1}{3}t^3-2t\right)\mathbf{j}\ (+\mathbf{D})$	A1	1.1b
	Substitute their t value into their position vector	M1	3.1a
	$\left(\frac{41}{16}\mathbf{i}-\frac{1}{32}\mathbf{j}\right)$ (m) oe	A1	1.1b
		(6)	
			(9 marks)

Notes: Accept column vectors throughout		
2a	M1	At least two powers increasing by 1.
	A1	Correct vector expression, with or without a constant.
	A1	cao
2b	M1	Complete method (M0 if two separate equations seen without elimination).
	A1	Correct t value.
	M1	At least two powers increasing by 1.
	A1	Correct vector expression, with or without a constant.
	M1	Using their t value correctly, including initial position.
	A1	cao

Question	Scheme	Marks	AOs
3(a)	Use the model to set up equation of motion for P	M1	3.4
	$kmg\sin\alpha - T = km \times \frac{1}{5}g$	A1	1.1b
		(2)	
3(b)	Use the model to set up equation of motion for Q or for the whole system	M1	3.3
	$T - mg = m \times \frac{1}{5}g$ or $kmg\sin\alpha - mg = (km+m) \times \frac{1}{5}g$	A1	1.1b
	Produce an equation in k only	M1	3.1a
	$k = 2$	A1	1.1b
		(4)	
3(c)	Resolve perpendicular to the plane for P	M1	3.4
	$R = kmg\cos\alpha = \frac{3}{5}kmg$	A1	1.1b
		(2)	
3(d)	Resolve parallel to the plane for P	M1	3.4
	$kmg\sin\alpha = T + F$	A1	1.1b
	Resolve vertically for Q: $T = mg$	B1	3.3
	Use of $F = \mu R$	M1	3.4
	Produce an equation in μ and k only	M1	2.1
	$\mu = \frac{4k-5}{3k}$	A1	1.1b
		(6)	
			(14 marks)

Notes:

3a	M1	Correct no. of terms and allow sin/cos confusion and sign errors.
	A1	Correct unsimplified equation.
3b	M1	Correct no. of terms, allow sin/cos confusion and sign errors.
	A1	Correct unsimplified equation.
	M1	Produce an equation in k only.
	A1	cao
3c	M1	Correct no. of terms and allow sin/cos confusion and sign errors.

	A1	cao
3d	M1	Correct no. of terms and allow sin/cos confusion and sign errors.
	A1	Correct unsimplified equation.
	B1	cao
		Alternative for first three marks M1 A1 B1: Whole system equation
	M1	Use of $F = \mu R$.
	M1	Produce an equation in μ and k only.
	A1	cao

Question	Scheme	Marks	AOs
4(a)	Moments about A	M1	2.1
	$F \times 2a \sin 30^o = mga + 2mg \times 1.5a$	A1	1.1b
	$F = 4mg$*	A1*	2.2a
		(3)	
4(b)	Resolve vertically: $V = mg + 2mg - 4mg \sin 30^o$ **OR**, Moments about B: $V \times 2a = mga + 2mg \times 0.5a$	M1	3.4
	$V = mg$	A1	1.1b
		(2)	
4(c)	Resolve horizontally:	M1	3.3
	$H = 4mg \cos 30^o$	A1	1.1b
	Use of $\tan\theta = \frac{V}{H}$	M1	2.1
	$\tan\theta = \frac{1}{2\sqrt{3}}$ or $\frac{\sqrt{3}}{6}$	A1	1.1b
		(4)	
			(9 marks)

Notes: N.B. In parts a and b, the M1 is for a complete method		
4a	M1	Dimensionally correct, correct no. of terms and allow sin/cos confusion and sign errors.
	A1	Correct unsimplified equation.
	A1*	Given answer correctly obtained.
4b	M1	Correct no. of terms and allow sin/cos confusion and sign errors.
	A1	cao
4c	M1	Correct no. of terms and allow sin/cos confusion and sign errors.
	A1	Correct unsimplified equation.
	M1	Allow RHS inverted.
	A1	cao

Question	Scheme	Marks	AOs
5(a)	Use $s = ut$ horizontally:	M1	3.3
	$10 = Ut\cos 45^o$	A1	1.1b
	Use $s = ut + \frac{1}{2}at^2$ vertically:	M1	3.4
	$5 = Ut\sin 45^o - \frac{1}{2}gt^2$	A1	1.1b
	Form an equation in U only: $5 = 10\tan 45^o - \frac{1}{2}g\left(\frac{10}{U\cos 45^o}\right)^2$	M1	2.1
	$U = 14$	A1	1.1b
		(6)	
5(b)	Use $v^2 = u^2 + 2as$ vertically: $v_V{}^2 = (14\sin 45^o)^2 - 2g \times 5$	M1	3.4
	$v_V = 0$	A1	1.1b
	speed = $14\sin 45^o = 9.9$ or 9.90 (m s^{-1})	A1	3.1b
		(3)	
5(c)	e.g. It ignores wind effects, it uses an inaccurate value for g, it ignores spin effects, it ignores the dimensions of the ball	B1	3.5b
		(1)	
5(d)	$V > U$ since air resistance would slow the ball down oe	B1	3.5a
		(1)	
			(11 marks)

Notes:		
5a	M1	Correct no. of terms and allow sin/cos confusion and sign errors.
	A1	Correct unsimplified equation.
	M1	Correct no. of terms and allow sin/cos confusion and sign errors.
	A1	Correct unsimplified equation.
	M1	Form an unsimplified equation in U only, g does not need to be substituted.
	A1	cao
5b	M1	Correct no. of terms and allow sin/cos confusion and sign errors.
	A1	Correct unsimplified equation.
	A1	2 sf or 3 sf only.
5c	B1	Any appropriate answer

5d	B1	cao