

Mark Scheme (Final)

Summer 2018

Pearson Edexcel GCE AS Mathematics

Statistics & Mechanics (8MA0/02)

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- 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.
- 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/indicative content will not be exhaustive.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, a senior examiner must be consulted before a mark is awarded.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

PEARSON EDEXCEL GCE MATHEMATICS

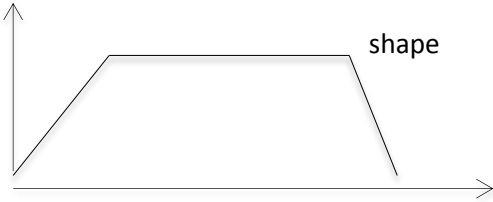
General Instructions for Marking

1. The total number of marks for the paper is 60.
2. These 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
 - **o.e.** – or equivalent (and appropriate)
 - **d** or **dep** – dependent
 - **indep** – independent
 - **dp** decimal places
 - **sf** significant figures
 - * The answer is printed on the paper or ag- answer given
4. All M marks are follow through.
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 answers that don't logically make sense e.g. if an answer given for a probability is >1 or <0 , should never be awarded A marks.

5. 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.
6. 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.
7. Ignore wrong working or incorrect statements following a correct answer.
8. Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternative 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. If no such alternative answer is provided but the response is deemed to be valid, examiners must escalate the response for a senior examiner to review.

Section B: Mechanics

Question	Scheme	Marks	AOs
6.	Equation in t only	M1	2.1
	$-2 = 9t - \frac{1}{2} \cdot 10t^2$	A1	1.1b
	$5t^2 - 9t - 2 = 0 = (5t+1)(t-2)$	DM1	1.1b
	$T = 2$ (only)	A1	1.1b
		(4)	
(4 marks)			
Notes:			
<p>M1: Complete method to give equation in t only. This mark is for a complete method for the TOTAL time i.e. for finding sufficient equations, with usual rules, correct no. of terms in each equation but condone sign errors and g does not need to be substituted</p> <p>A1: A correct equation or correct equations (e.g. if they find the speed, 11 ms^{-1}, when the ball strikes the ground and then use that to find the total time or if they split the time (e.g. 0.9s up and 1.1s down or 0.9s + 0.9s + 0.2s))</p> <p>N.B. $g = 10$ must be substituted in all equations used.</p> <p>DM1: Dependent on first M1, for solving a 3 term quadratic to find T or for solving their equations to find T or for solving their equations <u>and adding</u> their split times to find T</p> <p>A1: $T = 2$ only (i.e. A0 if they give two times)</p> <p>N.B. If solving a <u>correct</u> quadratic, the DM1 can be implied by a correct answer i.e. the method does not need to be shown, but if there is no method shown and the answer is wrong then award DM0 A0.</p>			

Question	Scheme	Marks	AOs
7(a) (i)	24 (m s ⁻¹)	B1	1.1b
	(ii) 48 (s)	B1	1.1b
	(iii) 	B1	1.1b
		(3)	
(b)	Equating area under graph to 4800 to give equation in one unknown	M1	3.1b
	$\frac{1}{2}(T + T + 80 + 48) \times 24 = 4800$ OR $(\frac{1}{2} \times 80 \times 24) + 24T + (\frac{1}{2} \times 48 \times 24) = 4800$ oe	A1ft	1.1b
	T = 136 so total time is 264 (s)	A1	1.1b
		(3)	
(c)	Accept Either: a smooth change from acceleration to constant velocity or from constant velocity to deceleration. Or have train accelerating and/or decelerating at a variable rate Do not accept e.g. Comments on air resistance or resistive forces, straightness of track, horizontal track, friction, length of train, mass of train, not having train moving with constant velocity. <u>B0 if either an incorrect extra is included or an incorrect reason for a valid improvement is included.</u> <u>N.B.</u> Variable acceleration due to air resistance is B0 BUT Variable acceleration due to variable air resistance is B1	B1	3.5c
		(1)	
			(7 marks)
Notes:			
(a)			
(i) B1: 24 (m s ⁻¹) Must be stated i.e. not just inserted on the graph			

(ii) B1: 48 (s) (Allow – 48 changed to 48) Must be stated i.e. not just inserted on the graph

(iii) B1: A trapezium starting at the origin and ending on the t -axis.

(b)

M1: Complete method to find area of trapezium using trapezium rule with correct structure or using two triangles and a rectangle and equate to 4800 to give equation in *one* unknown

N.B. $\frac{1}{2}(T + 80 + 48) \times 24 = 4800$ is M0 (equivalent to using three triangles)

OR they may use *suvat* on one or more sections (must have $a = 0$ for middle section) and equate total distance travelled to 4800 to give equation in *one* unknown

A1ft: For a correct equation in their unknown **ft** on their 24 and 48 (but must be positive times)

A1: For 264 (s)

(c)

B1:

Either: Include time to change from constant accln to constant velocity and/or time to change from constant velocity to constant deceleration oe

Or: Have train accelerating and/or decelerating at a variable rate

Question	Scheme	Marks	AOs
8(a)	Multiply out and differentiate wrt to time (or use of product rule i.e. must have two terms with correct structure)	M1	1.1a
	$v = 2t^3 - 3t^2 + t$	A1	1.1b
	$2t^3 - 3t^2 + t = 0$ and solve: $t(2t - 1)(t - 1) = 0$	DM1	1.1b
	$t = 0$ or $t = \frac{1}{2}$ or $t = 1$; any two	A1	1.1b
	All three	A1	1.1b
		(5)	
(b)	Find x when $t = 0, \frac{1}{2}, 1$ and 2 : $(0, \frac{1}{32}, 0, 2)$	M1	2.1
	Distance = $\frac{1}{32} + \frac{1}{32} + 2$	M1	2.1
	$2\frac{1}{16}$ (m) oe or 2.06 or better	A1	1.1b
		(3)	
(c)	$x = \frac{1}{2}t^2(t - 1)^2$	M1	3.1a
	$\frac{1}{2}$ perfect square so $x \geq 0$ i.e. never negative	A1 cso	2.4
		(2)	

(10 marks)

Notes:

(a)

M1: Must have 3 terms and at least two powers going down by 1

A1: A correct expression

DM1: Dependent on first M, for equating to zero and attempting to solve a cubic

A1: Any two of the three values (Two correct answers can imply a correct method)

A1: The third value

(b)

M1: For attempting to find the values of x (at least two) at their t values found in (a) or at $t = 2$ or equivalent e.g. they may integrate their v and sub in at least two of their t values

M1: Using a correct strategy to combine their distances (must have at least 3 distances)

A1: $2\frac{1}{16}$ (m) oe or 2.06 or better

(c)

M1: Identify strategy to solve the problem such as:

- (i) writing x as $\frac{1}{2} \times$ perfect square
- (ii) or using x values identified in (b).
- (iii) or using calculus i.e. identifying min points on $x-t$ graph.
- (iv) or using $x-t$ graph.

A1 cso : Fully correct explanation to show that $x \geq 0$ i.e. never negative

Question	Scheme	Marks	AOs
9(a)	Equation of motion for P	M1	3.3
	$2mg - T = 2m \cdot \frac{5g}{7}$	A1	1.1b
	$T = \frac{4mg}{7}$	A1	1.1b
		(3)	
(b)	Since the string is modelled as being inextensible	B1	3.4
		(1)	
(c)	Equation of motion for Q OR for whole system	M1	3.3
	$T - kmg = km \cdot \frac{5g}{7}$ OR $2mg - kmg = (km + 2m) \frac{5g}{7}$	A1	1.1b
	$\frac{4mg}{7} - kmg = km \cdot \frac{5g}{7}$ oe and <u>solve for k</u>	DM1	1.1b
	$k = \frac{1}{3}$ or 0.333 or better	A1	1.1b
		(4)	
(d)	e.g The model does not take account of the mass of the string (SEE BELOW for alternatives)	B1	3.5b
		(1)	

(9 marks)

Notes: Condone both equations of motion appearing in (a) if used in (c)

(a)

M1: Resolving vertically for P with usual rules, correct no. of terms but condone sign errors and a does not need to be substituted (N.B. inconsistent omission of m is M0). Allow ma on RHS for M1

A1: A correct equation (allow if they use 7 instead of $\frac{5g}{7}$)

A1: A correct answer of form cmg , where $c = \frac{4}{7}$ oe or 0.57 or better

(b)

B1: String is inextensible. N.B. B0 if any extras (wrong or irrelevant) given

(c)

M1: Resolving vertically for Q or for a whole system equation, with usual rules, correct no. of terms but condone sign errors and neither T nor a does need to be substituted

(N.B. inconsistent omission of m is M0 and M0 if k is omitted from LHS or RHS or both.)

A1: A correct equation (allow if they use 7 instead of $\frac{5g}{7}$)

DM1: Sub for T using their answer from (a), if necessary, and solve to give a numerical value of k (i.e. m 's must cancel)

A1: $k = \frac{1}{3}$ or 0.333 or better.

(d)

B1: e.g. Pulley may not be smooth

Pulley may not be light

Particles may not be moving freely e.g. air resistance

Balls may not be particles

String may not be light

String may not be inextensible

(but allow converses in all cases e.g. 'pulley smooth')

N.B. B0 if any extra incorrect answer is given BUT ignore incorrect consequence of a correct answer.

Also note: B0 : Use of a more accurate value of g