Mark Scheme Final

November 2021

Pearson Edexcel GCE Mathematics
Advanced Subsidiary Level in Mathematics
Mechanics Paper 22
8MA0/22

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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 75.

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.

Question	Scheme	Marks	AOs
1.(a)	$14.7 = -14.7 + 9.8T$ or $0 = 14.7T - \frac{1}{2} \times 9.8T^2$ or $0 = 14.7 - 9.8 \times \left(\frac{1}{2}T\right)$ oe	M1	3.4
	$T = 3$	A1	1.1b
		(2)	
(b)	$s_1 = \frac{(14.7 + 0)}{2} \times 1.5$ (11.025 or $\frac{441}{40}$)	M1	1.1b
	$s_2 = \frac{1}{2} \times 9.8 \times 2.5^2$ (30.625 or $\frac{245}{8}$) **OR** $s_3 = 14.7 \times 1 + \frac{1}{2} \times 9.8 \times 1^2$ (19.6 or $\frac{98}{5}$) **OR** $-s_3 = 14.7 \times 4 - \frac{1}{2} \times 9.8 \times 4^2$ (- 19.6) (allow omission of – on LHS)	M1	1.1b
	Total distance = $s_1 + s_2$ **OR** $2s_1 + s_3$	M1	2.1
	= 41.7 m or 42 m	A1	1.1b
		(4)	
(c)	e.g. Take account of the dimensions of the stone (e.g. allow for spin), do not model the stone as a particle, use a more accurate value for *g*	B1	3.5c
		(1)	
			(7 marks)

Notes:		**If they use g = 9.81 or 10, penalise once for whole question.**
1a	M1	Complete method to find *T*, condone sign errors (M0 if they only find time to top)
	A1	*T* = 3 correctly obtained.
1b	M1	Complete method to find one key distance
	M1	Correct method to find another key distance
	M1	Complete method to find the total distance
	A1	41.7 or 42 (after use of *g* = 9.8)
1c	B1	B0 if there are incorrect extra refinements but ignore extra incorrect statements.

Question	Scheme	Marks	AOs
2(a)	Differentiate v w.r.t. t	M1	3.1a
	$a = \frac{\mathrm{d}v}{\mathrm{d}t} = 10 - 2t$ isw	A1	1.1b
		(2)	
2(b)	Solve problem using $v = 0$ when $t = 6$	M1	3.1a
	$0 = 10t - t^2 - 24$	A1	1.1b
	Solve quadratic oe to find other value of t	M1	1.1b
	$t = 4$	A1	1.1b
		(4)	
2(c)	Integrate v or $-v$ w.r.t. t	M1	3.1a
	$5t^2 - \frac{1}{3}t^3 - 24t$	A1	1.1b
	Total distance = $-\left[5t^2 - \frac{1}{3}t^3 - 24t\right]_0^4 + \left[5t^2 - \frac{1}{3}t^3 - 24t\right]_4^6$	M1	2.1
	$\frac{116}{3}$ (m)	A1	1.1b
		(4)	
			(10 marks)

Notes:		
2a	M1	Differentiate, with both powers decreasing by 1
	A1	Correct expression
2b	M1	Put $t = 6$ **OR** use $(t-6)(t-x) = t^2 - 10t + k$ oe
	A1	Correct expression (unsimplified) for v **OR** $v = (t-6)(t-4)$
	M1	Put $v = 0$ to give quadratic in t and solve for other value of t
	A1	$t = 4$
2c	M1	Integrate, with at least two powers increasing by 1 (allow if only two terms integrated)
	A1	Correct expression
	M1	Complete method to find the total distance
	A1	Accept 39(m) or better

Question	Scheme	Marks	AOs
3(a)	(i) Equation of motion for P	M1	3.3
	$T - 2mg = 2ma$	A1	1.1b
	(ii) Equation of motion for Q	M1	3.3
	$5mg - T = 5ma$	A1	1.1b
	N.B. (allow (-a) in both equations)	**(4)**	
3(b)	Solve equations for a or use whole system equation and solve for a	M1	3.4
	$a = \frac{3g}{7} = 4.2$	A1	1.1b
	$v = \sqrt{2 \times \frac{3g}{7} \times h} = \sqrt{8.4h}$ or $v^2 = 2 \times \frac{3g}{7} \times h$ $(= 8.4h)$	M1	1.1b
	$0 = \frac{6gh}{7} - 2gH$	M1	1.1b
	$H = \frac{3h}{7}$	A1	1.1b
	Total height = $2h + h + H$	M1	2.1
	Total height = $\frac{24h}{7}$	A1	1.1b
		(7)	
3(c)	e.g. The distance that Q falls to the ground would not be exactly h oe	B1	3.5b
		(1)	
3(d)	e.g. The accelerations of the balls would not have equal magnitude (allow 'wouldn't be the same' oe) B0 if they say 'inextensible => acceleration same'	B1	3.5a
		(1)	
			(13 marks)

Notes:

3a	M1	Translate situation into the model and set up the equation of motion for P (must contain T and a)
	A1	Correct equation
	M1	Translate situation into the model and set up the equation of motion for Q(must contain T and a)
	A1	Correct equation
		N.B. Allow the above 4 marks if the equations appear in (b).

		If *m*'s are omitted consistently, max (a) M1A0M1A0 (b)M1A0M1M1A1M1A0
3b	M1	Solve for *a*
	A1	Allow 4.2 ($\mathrm{m\,s^{-2}}$) or must be in terms of *g* only.
		N.B. Allow the above 2 marks if they appear in (a).
	M1	Complete method to produce an expression for *v* or v^2 in terms *h*, using their *a*
	M1	Complete method to produce an expression for *H* in terms of *h* ,using $a = -g$ and $v = 0$
	A1	Correct expression for *H*
	M1	Complete method to find the total distance
	A1	cao but allow 3.4*h* or better
3c	B1	B0 if any incorrect extras are given
3d	B1	B0 if any incorrect extras are given or for an incorrect statement e.g. tension is not constant so accelerations will be different