Mark Scheme (Results)

Summer 2019

Pearson Edexcel GCE
In Mathematics (8MA0) Paper 2 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.

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.

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, 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. 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.

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.

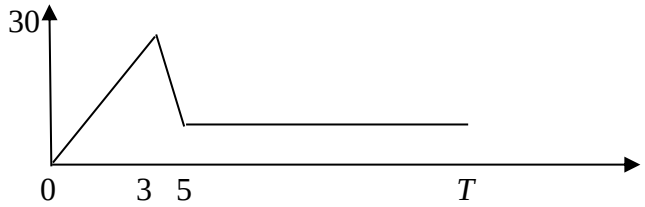
• Misreads – if a misread does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, bearing in mind that after a misread, the subsequent A marks affected are treated as A ft

• 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.

8MA0 22: Mechanics AS 1906 Mark Scheme

Question	Scheme	Marks	AOs	Notes
1 (a)	$V = 30$ (m s^{-1})	B1	3.4	cao
		(1)		
(b)	 shape	B1	1.1b	Overall shape of the graph, starting at the origin. Dotted vertical line at end is OK but solid vertical line is B0
	figs	B1**ft**	1.1b	3, 5 and T marked on the t-axis, and **ft** on their 30 marked on the speed axis. 3 must be where graph reaches a peak. Allow delineators: 3, 2 and T – 5 or a mixture
		(2)		
(c)	Using total area = 550 to set up an equation in **one unknown,** Or they may use *suvat* on one or more of the sections (but must still be considering all sections) M0 if they use one *suvat* equation for the whole motion	M1	2.1	Need all sections to be included, with <u>correct structure for each section.</u> e.g. triangle + trapezium + rectangle oe = 550 to give an equation in **one unknown (may not be *T*)**
	$\frac{1}{2}\times 3\times 30+\frac{(30+6)}{2}\times 2+6(T-5)=550$ **OR**: $\frac{1}{2}\times 3\times 30+\frac{1}{2}\times 2\times 24+6(T-3)=550$ **OR:** $\frac{1}{2}\times 3\times 30+\frac{1}{2}\times 2\times 24+(2\times 6)+6(T-5)=550$	A2 **ft**	1.1b	**ft** on their answer to (a). -1 each error. **N.B.** If '6' is incorrect, treat as one error, unless it is correct ft from their 30.

	Solve for T	M1	1.1b	Attempt to solve for T provided they have tried to find the area using at least 3 sections. (M0 if they only solve for their unknown and never try to find T)
	$T = 83$ (nearest whole number)	A1	1.1b	83 is the only answer
		(5)		
(d)	New value of T would be bigger (ignore their reasons whether correct or not)	B1	3.5a	Clear statement about the value of T Allow '*it* would increase, get larger etc' B0 for 'Takes longer' or 'the value of T would be longer'
		(1)		
(e)	e.g. effect of wind; allow for dimensions of parachutist; use a more accurate value for g; parachutist does not fall vertically after chute opens; smooth changes in v; time for parachute to open; deceleration not constant (but B0 if they say *acceleration* not constant); smooth changes in a; B0 for: moves horizontally; mass/weight of parachutist; upthrust; air pressure;air resistance; terminal velocity	B1	3.5c	Any appropriate refinement of the model. B0 if incorrect (or irrelevant) extras
		(1)		
		(10 marks)		

N.B. Omission or extra g in a resolution is an accuracy error not a method error

In 2(a), use the mass which appears in the '*ma*' term of an equation of motion, to identify which particle that equation of motion applies to.

Question	Scheme	Marks	AOs	Notes
2(a)	Equation of motion for Q	M1	3.3	Equation of motion for Q with correct no. of terms, condone sign errors.
	$0.6g - T = 0.6a$	A1	1.1b	A correct equation
	Equation of motion for P	M1	3.3	Equation of motion for Q with correct no. of terms, condone sign errors.
	$T = 0.8a$	A1	1.1b	A correct equation
	$a = 4.2$ (m s^{-2}) *	A1*	2.2a	Given acceleration obtained correctly. **You must see an equation in a only before reaching $a = 4.2$**
		(5)		**N.B.** if they just use the whole system equation: $0.6g = 1.4a$, can only score max M1A1M0A0A0 **N.B**. Use of g = 9.81 or 10 loses final A mark only. **N.B.** Complete verification, using both equations, can score full marks.

(b)	$0.4=\frac{1}{2}\times 4.2\times t_1^{\,2}$ or e.g. they may find v first and then use $v = 4.2\,t_1$	M1	2.1	Complete method (they may use more than one *suvat* equation) to find time for Q to hit the floor (M0 if 0.4 **not** used as distance moved and/or if 4.2 is **not** used as acceleration and this applies to finding v as well if they use v to find t_1)
	$t_1 = 0.436\,(4357\ldots..)$ Allow 0.43, 0.44, 0.436, or better, or any surd form e.g. $\frac{2}{\sqrt{21}}$	A1	1.1b	See alternatives
	$v = 4.2\times t_1$ or $v=\sqrt{2\times 4.2\times 0.4}$ or $0.4 = \frac{(0+v)}{2}\times t_1$ ($v = 1.8330\ldots$)	M1	3.4	Complete method to find speed of Q as it hits the floor (M0 if 0.4 **not** used as distance moved and/or if 4.2 is **not** used as acceleration and this applies to finding t_1 as well if they use t_1 to find v)
	$t_2 = \frac{1.5-0.4}{v}$	M1	1.1b	Uses distance/speed to find time for P to hit the pulley after Q has hit the floor. N.B. This is independent of previous M mark.
	Complete strategy to solve the problem by finding the sum of the two times $t_1 + t_2$	**DM**1	3.1b	Complete method to solve the problem by finding and adding the two required times, dependent on previous three M marks
	1.0 (s) or 1.04 (s)	A1	1.1b	
		(6)		
(c)	e.g. rope being light; rope being inextensible; pulley being smooth; pulley being small; balls being particles	B1	3.5b	Clear statement. Allow negatives of these i.e. the rope may not be light, the rope may not be inextensible etc Must be a limitation of the model stated in the question Penalise incorrect or irrelevant extras
		(1)		B0 for: Air resistance, table being smooth
		(12 marks)		

Question	Scheme	Marks	AOs	Notes
3(a)	$v = 12 + 4t - t^2 = 0$ and solving	M1	3.1a	Equating v to 0 and solving the quadratic If no evidence of solving, and at least one answer wrong, M0
	$t = 6$ (or -2)	A1	1.1b	6 but allow -2 as well at this stage
	Differentiate v wrt t	M1	1.1a	For differentiation (both powers decreasing by 1)
	$(a = \frac{dv}{dt} =) \ 4 - 2t$	A1	1.1b	Cao; only need RHS
	When $t = 6$, $a = -8$; Magnitude is 8 (m s^{-2})	A1	1.1b	Substitute in $t = 6$ and get 8 (m s^{-2}) as the answer . Must be **positive.** (A0 if two answers given)
		(5)		
(b)	Integrate v wrt t	M1	3.1a	For integration (at least two powers increasing by 1)
	$(s =) 12t + 2t^2 - \frac{1}{3}t^3 (+C)$	A1	1.1b	Correct expression (ignore C) only need RHS Must be used in part (b)
	$t = 3$ => distance = 45 (m)	A1	1.1b	Correct distance. Ignore units
		(3)		
		(8 marks)		

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