January 2019

Mark Scheme

Mock Paper (Set1)

Pearson Edexcel GCE A Level Mathematics

Mechanics (9MA0/32)

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

January 2019
Publications Code xxxxxxxx*

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 100

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.

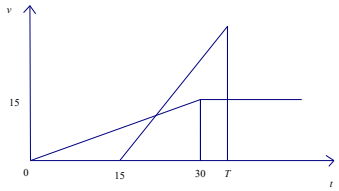
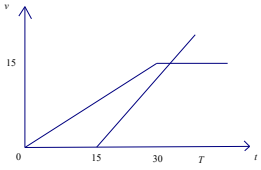
   A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but answers that don't logically make sense e.g. if an answer given for a probability 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.

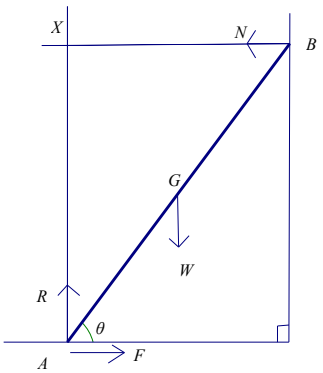
6. Where a candidate has made multiple responses and indicates which response they wish to submit, examiners should mark this response.
   If there are several attempts at a question which have not been crossed out, examiners should mark the final answer which is the answer that is the most complete.

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, 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.

Question	Scheme	Marks	AOs
1(a)			
	One line correct	B1	3.4
	Second line correct and with correct start relative to the first line and steeper gradient Condone 	B1	1.1b
	Key values shown	B1	1.1b
		(3)	
1(b)	Equate distances	M1	3.4
	Car: $\frac{1}{2}\times 30\times 15+15(T-30)$	A1	1.1b
	Motorbike: $\frac{1}{2}\times(T-15)\times\frac{3}{2}(T-15)\left(=\frac{3}{4}(T-15)^2\right)$ $\Rightarrow\frac{3}{4}(T-15)^2=15^2+15(T-30)$	A1	1.1b
	$T^2-50T+525=0$, $T=35$	M1	1.1b
	$\text{Speed}=(35-15)\times 1.5$	M1	1.1b
	$=30$ (m s^{-1})	A1	2.2a
		(6)	
			(9 marks)

Notes:		
1(a)	B1	Either line correct
	B1	Second line in correct position to the first and both continue until after the car reaches constant speed.
	B1	15, 30, T and 15 shown
1(b)	M1	Use the fact that to catch up they must both have travelled the same distances.
	A1	One distance expressed correctly in terms of T
	A1	Both distances correct. Correct equation in T in any equivalent form
	M1	Create and solve a quadratic in T.
	M1	Use their T to find the required speed.
	A1	Correct only. If speed = 0 seen then it must be rejected.

Question	Scheme	Marks	AOs
2a			
	Moments about A:	M1	3.3
	$W \times a\cos\theta = N \times 2a\sin\theta \quad (W = 2N\tan\theta)$	A1	1.1b
	$\updownarrow R = W$	B1	3.4
	$\leftrightarrow F = N$	B1	3.4
	$F = \mu R \Rightarrow N = \mu W$	M1	1.2
	Complete strategy to form an equation in μ and θ	M1	3.1b
	$N = \mu \times 2N\tan\theta$, $\mu = \dfrac{1}{2\tan\theta}$ *	A1*	2.2a
		(7)	
2b	Position of centre of mass affects value of N, which affects value of μ	B1	3.5a
	Closer to A, μ smaller, further from A, μ larger	B1	2.4
		(2)	
			(9 marks)

Notes:		
2a	M1	Moments equation. Must be dimensionally correct and include all terms. Condone sign errors. Alternative equations: M(B): $2a\sin\theta\times F + a\cos\theta\times W = 2a\cos\theta\times R$ M(G): $a\sin\theta\times N + a\sin\theta\times F = a\cos\theta\times R$ M(X): $2a\sin\theta\times F = a\cos\theta\times W$
	A1	Correct unsimplified equation
	B1	Second equation e.g. by resolving vertically
	B1	Achieve a complete set of equations to solve for μ
	M1	Use of $F = \mu R$
	M1	Complete strategy to form an equation in μ and θ e.g. by taking moments, resolving and eliminating other variables.
	A1*	Derive the given result from correct working.
2b	B1	Correct reasoning
	B1	Correct conclusion

Question	Scheme	Marks	AOs
3(a)	$\mathbf{v} = \frac{\mathrm{d}}{\mathrm{d}t}(\mathbf{r})$	M1	1.1b
	$\mathbf{v} = \left(3t^2 - 5\right)\mathbf{i} + \left(10t + 6\right)\mathbf{j}$	A1	1.1b
	Parallel to $\left(\mathbf{i} + 2\mathbf{j}\right) \Rightarrow \left(10T + 6\right) = 2\left(3T^2 - 5\right)$	M1	3.1a
	$6T^2 - 10T - 16 = 0$	A1	1.1b
	$T = \frac{8}{3}$	A1	2.2a
		(5)	
(b)	$\mathbf{a} = \frac{\mathrm{d}}{\mathrm{d}t}(\mathbf{v}), \quad \left(\mathbf{a} = 6t\mathbf{i} + 10\mathbf{j}\right)$	M1	1.1b
	$\mathbf{F} = 0.5\left(12\mathbf{i} + 10\mathbf{j}\right)\left(= 6\mathbf{i} + 5\mathbf{j}\right)$	M1	2.1
	$\left\|\mathbf{F}\right\| = \sqrt{6^2 + 5^2}$	M1	1.1b
	$= \sqrt{61}\left(= 7.8(1....)\right)$	A1	1.1b
		(4)	
			(9 marks)

Notes:

(a)	M1	Differentiate – majority of powers going down, correct coefficient of t or t^2.
	A1	Any equivalent form
	M1	Use ratio to form equation in T.
	A1	Correct unsimplified expression in T. Any equivalent form
	A1	Correct only. Allow 2.7 or better. If $T = -1$ is seen, it must be rejected.
(b)	M1	Differentiate their **v** to obtain **a**
	M1	Substitute $t = 2$ and use $\mathbf{F} = m\mathbf{a}$
	M1	Use of Pythagoras to find modulus of **F** or **a**
	A1	7.8 or better

Question	Scheme	Marks	AOs
4(a)	$(\lambda\mathbf{i} = 9\mathbf{i})\quad \lambda = 9$	B1	3.3
	Vertical distance:	M1	3.4
	$9^2 = 12^2 - 2gh$	A1ft	1.1b
	$h = 3.2(1)$	A1	1.1b
		(4)	
(b)	Min speed = 9 (m s^{-1})	B1	2.2a
		(1)	
(c)	Vertical component of velocity $= \sqrt{12^2 - 9^2}\ \left(= \sqrt{63}\right)$	M1	3.1b
	$\Rightarrow -\sqrt{63} = \sqrt{63} - gt$	A1ft	1.1b
	Complete strategy to find the required time	M1	3.1b
	$t = 1.6(2)$ (s)	A1	2.2a
		(4)	
(d)	Consider the dimensions of the ball	B1	3.5c
		(1)	
			(10 marks)

Notes:

(a)	B1	Comparison of horizontal components of velocities.
	M1	Use the model and *suvat* to form an equation in h. Condone sign errors
	A1ft	Correct unsimplified equation. Follow their λ .
	A1	3.2 or 3.21 only (follows use of 9.8)
(b)	B1	Correct answer only
(c)	M1	Use of Pythagoras to find vertical component
	A1ft	Correct unsimplified equation in t OR find both solutions of $12 - gt = \pm\sqrt{63}$. Follow their vertical component.
	M1	Complete strategy for the required time e.g. find the vertical component of the velocity when speed is 12 m s^{-1} and use *suvat*
	A1	1.6 or 1.62 only (follows use of 9.8)
(d)	B1	e.g consider the dimensions of the ball the ball could be spinning the effect of the wind

Question	Scheme	Marks	AOs
5(a)	Motion of A:	M1	3.4
	$T - 3g\sin\theta = 3a$	A1	1.1b
	Motion of B:	M1	3.4
	$3g - T = 3a$	A1	1.1b
	Complete strategy to find tension	M1	3.1b
	$\Rightarrow T - 3g\sin\theta = 3g - T, \quad 2T = 3g(1+\sin\theta) = \frac{27g}{7}$ $T = 18.9 \quad (19)$	A1	2.1
		(6)	
(b)	Obtain $a = 3.5$	B1	1.1b
	Speed when B reaches the ground: $v^2 = 2\times 3.5\times 0.8 (= 5.6)$	M1	3.3
	Magnitude of the accn. of A when the string is slack: $g\sin\theta$	B1	3.1b
	Extra distance: $0 = 5.6 - 2\times g\sin\theta\times s \quad (s = 1)$	M1	3.1b
	Total distance 1.8 m	A1	2.2a
		(5)	
(c)	If the rope is not inextensible then cannot assume equal acceleration The model takes no account of the size of the packages	B1 B1	3.5b 3.5b
		(2)	
			(13 marks)

Notes:		
(a)	M1	Use the model to form equation of motion for A or B. Must include all relevant terms. Condone sign errors and sin/cos confusion
	A1	Correct unsimplified equation
	M1	Use the model to form second equation of motion. Condone a combined equation
	A1	Correct unsimplified equation
	M1	Complete strategy e.g. form simultaneous equations using equations of motion for A and B and solve for T
	A1	2sf or 3sf or $\frac{27g}{14}$.
(b)	B1	Accept $\frac{5g}{14}$ Correct model for motion, seen or implied
	M1	Complete method using *suvat* to find v or v^2 using $v^2 = 2as$ for their $a \neq g$
	B1	Correct model for motion when the string is slack
	M1	Complete method using *suvat* to find the additional distance using $a \neq$ their 3.5
	A1	Any equivalent form
(c)	B1 B1	Any 2 independent limitations/consequences of the modelling assumptions e.g Have not considered air resistance which will affect the tension, if the rope is not light then the tension in it is not constant, if the pulley is not smooth then the tension is not the same on either side of the pulley.