AS
FURTHER MATHEMATICS
7366/2M

Paper 2 Mechanics

Mark scheme

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236A7366/2M/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Mark scheme instructions to examiners

General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- marking instructions that indicate when marks should be awarded or withheld including the principle on which each mark is awarded. Information is included to help the examiner make his or her judgement and to delineate what is creditworthy from that not worthy of credit
- a typical solution. This response is one we expect to see frequently. However credit must be given on the basis of the marking instructions.

If a student uses a method which is not explicitly covered by the marking instructions the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

Key to mark types

M	mark is for method
R	mark is for reasoning
A	mark is dependent on M marks and is for accuracy
B	mark is independent of M marks and is for method and accuracy
E	mark is for explanation
F	follow through from previous incorrect result

Key to mark scheme abbreviations

CAO	correct answer only
CSO	correct solution only
ft	follow through from previous incorrect result
‘their’	indicates that credit can be given from previous incorrect result
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
NMS	no method shown
PI	possibly implied
sf	significant figure(s)
dp	decimal place(s)
ISW	Ignore Subsequent Workings

Examiners should consistently apply the following general marking principles:

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

Diagrams

Diagrams that have working on them should be treated like normal responses. If a diagram has been written on but the correct response is within the answer space, the work within the answer space should be marked. Working on diagrams that contradicts work within the answer space is not to be considered as choice but as working, and is not, therefore, penalised.

Work erased or crossed out

Erased or crossed out work that is still legible and has not been replaced should be marked. Erased or crossed out work that has been replaced can be ignored.

Choice

When a choice of answers and/or methods is given and the student has not clearly indicated which answer they want to be marked, mark positively, awarding marks for all of the student's best attempts. Withhold marks for final accuracy and conclusions if there are conflicting complete answers or when an incorrect solution (or part thereof) is referred to in the final answer.

AS/A-level Maths/Further Maths assessment objectives

AO		Description
AO1	AO1.1a	Select routine procedures
	AO1.1b	Correctly carry out routine procedures
	AO1.2	Accurately recall facts, terminology and definitions
AO2	AO2.1	Construct rigorous mathematical arguments (including proofs)
	AO2.2a	Make deductions
	AO2.2b	Make inferences
	AO2.3	Assess the validity of mathematical arguments
	AO2.4	Explain their reasoning
	AO2.5	Use mathematical language and notation correctly
AO3	AO3.1a	Translate problems in mathematical contexts into mathematical processes
	AO3.1b	Translate problems in non-mathematical contexts into mathematical processes
	AO3.2a	Interpret solutions to problems in their original context
	AO3.2b	Where appropriate, evaluate the accuracy and limitations of solutions to problems
	AO3.3	Translate situations in context into mathematical models
	AO3.4	Use mathematical models
	AO3.5a	Evaluate the outcomes of modelling in context
	AO3.5b	Recognise the limitations of models
	AO3.5c	Where appropriate, explain how to refine models

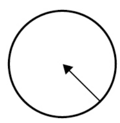
Q	Marking instructions	AO	Marks	Typical solution
1	Circles correct answer	1.1b	B1	18 J
	Question total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
2	Circles correct answer	1.2	B1	$e = 1$
	Question total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
3	Circles correct answer	1.1b	B1	10 J
	Question total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
4(a)	Obtains $\omega = \frac{\pi}{3}$ OE AWRT 1.05	1.1b	B1	$\omega = \frac{10 \times 2\pi}{60}$ $= \frac{\pi}{3}$
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
4(b)(i)	Recalls any correct formula related to motion in a horizontal circle for F or a	1.1a	M1	$F = mr\omega^2$ $F = 40(5)(\frac{\pi}{3})^2$ $= 219.32$ $= 220$ N
	Obtains the correct F using their value of ω Condone missing or incorrect units. AWRT 220 to 2 significant figures. FT their value of ω but their F must be to at least 2 significant figures.	1.1b	A1F	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
4(b)(ii)	Shows a radial force from Reena directed towards the centre of the circle	1.1b	B1	
	Subtotal		**1**	

	Question total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
5(a)	Obtains 13 N s Condone missing or incorrect units.	1.1b	B1	$\sqrt{(-5)^2+(12)^2}=13\,\text{Ns}$
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
5(b)	Recalls impulse = change in momentum. PI by vectors or magnitudes substituted into a formula for impulse.	1.2	M1	$\mathbf{I}=m\mathbf{v}-m\mathbf{u}$ $\begin{bmatrix}-5\\12\end{bmatrix}=5\mathbf{v}-5\begin{bmatrix}6\\2\end{bmatrix}$ $\mathbf{v}=\begin{bmatrix}5\\4.4\end{bmatrix}$ Speed = 6.7 m s^{-1}
	Uses $\mathbf{I}=m\mathbf{v}-m\mathbf{u}$ and substitutes the given vectors and mass correctly. PI by sight of $\begin{bmatrix}5\\4.4\end{bmatrix}$	1.1b	A1	
	Obtains correct speed. AWRT 6.7 Condone missing or incorrect units.	1.1b	A1	
	Subtotal		**3**	

	Question total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
6(a)	Applies dimensional analysis to the given equation. Condone use of $[k]=k$	1.1a	M1	$[y]=[x]-\frac{[k][x^2]}{[u^2]}$
	Uses the correct dimensions for u and either x or y Use of units scores A0	1.1b	A1	$L=L-\frac{[k]L^2}{(LT^{-1})^2}$
	Obtains $[k]=LT^{-2}$ Use of units scores A0	1.1b	A1	$L=L-\frac{[k]L^2}{L^2T^{-2}}$ $L=L-[k]T^2$ $[k]=LT^{-2}$
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
6(b)	Deduces that LT^{-2} represents an acceleration	2.2a	E1	k represents an acceleration
	Subtotal		**1**	

	Question total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
7(a)(i)	Uses the formula for e and substitutes the four velocities specified in the question to obtain a value for e or Obtains an expression for the velocity of A in terms of e	3.1b	M1	$e = \frac{3.5 + 2.5}{5 - 3} = 3$ This is impossible since $e \leq 1$ Hence sphere A cannot reverse direction
	Obtains either $e = 3$ or $v_A = 3.5 - 2e$ **and** uses $e \leq 1$ to deduce that sphere A cannot reverse its direction.	2.2a	R1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
7(a)(ii)	Deduces $e = \frac{1}{2}$ OE	2.2a	R1	$e = \frac{3.5 - 2.5}{5 - 3} = \frac{1}{2}$
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
7(b)	Forms a conservation of momentum equation with at least two terms correct	1.1a	M1	Conservation of momentum $5m + 0.6(3) = 2.5m + 0.6(3.5)$ $2.5m = 0.3$ Mass of sphere A = 0.12 kg
	Forms a fully correct momentum equation	1.1b	A1	
	Obtains mass = 0.12 kg Must include units.	1.1b	A1	
	Subtotal		**3**	

	Question total		**6**	

Q	Marking instructions	AO	Marks	Typical solution
8(a)	Obtains GPE = 54880 Accept 5600g or 54936 or 56000	1.1b	B1	GPE at bridge $mg\text{h} = 70(9.8)(80) = 54880$ J EPE at water level $\frac{\lambda x^2}{2l} = \frac{2800(80-L)^2}{2L}$ Conservation of energy $\frac{2800(80-L)^2}{2L} = 54880$ Since $L < 80$, $L = 40.3$ Hence $L = 40$
	Recalls and uses the formula correctly for EPE	3.1b	B1	
	Uses $x = 80 - L$ OE	1.1b	B1	
	Applies conservation of energy to form an equation using GPE and EPE in terms of L with their extension or Applies conservation of energy to form an equation using GPE and EPE in terms of x and finds a value for L	3.4	M1	
	Deduces $L = 40$ AWRT 40 to 2 sig fig	2.2a	A1	
	Subtotal		**5**	

Q	Marking instructions	AO	Marks	Typical solution
8(b)	Explains that if Omar is not modelled as a particle then his height must be considered	3.5b	E1	If Omar is not modelled as a particle then his height must be considered 40 m would therefore be too long, and Omar would end up in the water. Hence L < 40
	Infers that the length found in part **(a)** would be too long	2.2b	E1	
	Subtotal		**2**	

	Question total		**7**	

Q	Marking instructions	AO	Marks	Typical solution
9(a)(i)	Obtains the correct driving force of 5100	3.4	B1	$P = Fv$ $F = \frac{51\,000}{10} = 5100$ N Using Newton's Second Law $5100 - R = 1000(4.9)$ $R = 5100 - 4900$ $R = 200$
	Forms an equation to find R using Newton's Second Law	1.1a	M1	
	Completes reasoned argument to show that $R = 200$	2.1	R1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
9(a)(ii)	Translates problem into forming an equation for v using driving force = 200	3.3	M1	At maximum speed driving force = resistance $\frac{51\,000}{v} = 200$ $v = 255$ m s^{-1}
	Obtains $v = 255$ m s^{-1} Condone missing or incorect units	1.1b	A1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
9(b)(i)	Forms an equation using v = 10 and R = 200	3.4	M1	When v = 10 , R = 200 $200 = 10k$ $k = 20$
	Obtains k = 20	1.1b	A1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
9(b)(ii)	Translates problem into forming an equation for v using driving force = their kv FT their k	3.3	M1	At maximum speed driving force = resistance $\frac{51000}{v} = 20v$ $v = 50.5$
	Solves their equation correctly to find their v Condone missing or incorrect units ACF AWRT 50	1.1b	A1F	

	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
9(c)	Explains that Model 1 is unrealistic and gives a reason eg • Speed is too high. • Resistances are never constant. There must be a judgement relating to the validity of the model.	3.5a	E1	Model 1 is not realistic as resistances are not constant Model 2 is more realistic as it includes a variable resistance
	Explains that Model 2 is more realistic and gives a reason eg • Maximum speed is more realistic. • Allows for variable resistances. Note may refer to speed limits eg 50 mph = 22 m s^{-1} There must be a judgement relating to the validity of the model.	3.5b	E1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
9(d)	Suggests a further appropriate model of the form $f(v)$ that could be considered. Accept in words if clearly a description of a suitable $f(v)$. For example: Use resistance proportional to the square of the velocity.	3.5c	E1	Christina could model the resistance force as kv^2
	Subtotal		**1**	

	Question total		**12**	

	Question Paper total		**40**	