AQA

AS
FURTHER MATHEMATICS
7366/2M

Paper 2 Mechanics

Mark scheme

June 2024

Version: 1.0 Final

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.

No student should be disadvantaged on the basis of their gender identity and/or how they refer to the gender identity of others in their exam responses.

A consistent use of 'they/them' as a singular and pronouns beyond 'she/her' or 'he/him' will be credited in exam responses in line with existing mark scheme criteria.

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

Copyright information

AQA retains the copyright on all its publications. However, registered schools/colleges for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to schools/colleges to photocopy any material that is acknowledged to a third party even for internal use within the centre.

Copyright © 2024 AQA and its licensors. All rights reserved.

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 the 1st answer.	1.1b	B1	1.25 J
	Question total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
2	Circles the 2nd answer.	2.2a	R1	MLT^{-1}
	Question total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
3	Circles the 2nd answer.	1.1b	B1	0.4 rad s^{-1}
	Question total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
4(a)	Obtains 25. Condone missing or incorrect units.	1.1b	B1	$\text{KE} = \frac{1}{2}mv^2$ $= \frac{1}{2}(0.5)(10)^2$ $= 25$ J
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
4(b)	Uses conservation of energy to form an equation in h with PE and their KE from part **(a)**.	3.3	M1	$mgh = 25$ $h = \frac{25}{(0.5)(9.8)} = 5.102...$ Therefore, height reached is approx. 5.1 m above point of projection.
	Solves the energy equation to obtain $h = 5.1$ m Obtains correct value (5.10) to at least 3 sf or $\frac{25}{4.9}$ oe Condone missing units. AG	1.1b	A1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
4(c)(i)	Translates problem into finding difference between two energy terms.	3.3	M1	Work done $= 25 - (0.5)(9.8)(4.4)$ $= 25 - 21.56$ $= 3.44$ J
	Obtains AWRT 3.4 J Condone missing units. Do not ISW	1.1b	A1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
4(c)(ii)	Forms an equation using work done from part **(c)(i)** = R times 4.4	3.4	M1	$R \times 4.4 = 3.44$ $R = \frac{43}{55} = 3.44$ $R = 0.78$
	Obtains AWRT 0.78 or AWRT 0.77 Follow through their answer from **(c)(i)**.	1.1b	A1F	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
4(c)(iii)	Explains that resistance is unlikely to be constant (model not valid) as it would **vary according to speed**.	3.5b	E1	A constant resistance force is not realistic as resistance would decrease as the speed decreases.
	Subtotal		**1**	

	Question total		**8**	

Q	Marking instructions	AO	Marks	Typical solution
5	Obtains 1500 PI by $k = 30$	3.4	B1	$P = Fv$ $F = \frac{75000}{50} = 1500\,\text{N}$ Using Newton's Second Law $F - kv = ma$ At max speed $a = 0$ $1500 - 50k = 0$ $k = 30$
	Obtains $1500 - 50k$ or $1500 - kv$ or $1500 = 50k$ Allow their 1500 PI by $k = 30$	3.4	M1	
	Explains that at maximum speed $a = 0$ or Driving Force = Resistance at maximum speed OE	2.4	E1	
	Obtains $k = 30$	1.1b	A1	
	Question total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
6	States or clearly uses $[2\pi] = 1$ or is dimensionless. Condone no units.	1.2	B1	$[2\pi] = 1$ $t = 2\pi\sqrt{\frac{r^3}{Gm}}$ $G = \frac{4\pi^2 r^3}{mt^2}$ $[G] = \frac{[4\pi^2][r^3]}{[m][t^2]}$ $[G] = \frac{1 \times L^3}{MT^2}$ $[G] = L^3M^{-1}T^{-2}$
	Uses dimensional analysis to form an equation to find the dimensions of G Must use dimensions not units.	1.1a	M1	
	Obtains L^3 or M^{-1} or T^{-2} Condone use of units for this mark.	1.1a	M1	
	Obtains $L^3M^{-1}T^{-2}$ for the dimensions of G	1.1b	A1	
	Question total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
7(a)	Forms a correct definite integral for impulse. Condone one error	3.4	M1	Impulse $= \int_0^{\ln 8} (6e^t + 2e^{2t})dt$
	Obtains 105 Ns Condone missing units.	1.1b	A1	$= 105$ Ns
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
7(b)	States that $I = mv - mu$ Or States $a = 3e^t + e^{2t}$	1.2	B1	$I = mv - mu$ $2(v) - 2(5) = 105$ $v = 57.5$ m s^{-1}
	Forms the equation $2(v) - 2(5) =$ their impulse from part **(a)**. Or Obtains $v = 3e^t + \frac{1}{2}e^{2t} + \frac{3}{2}$	1.1a	M1	
	Obtains 57.5 Follow through their answer to part **(a)**. Condone missing units.	1.1b	A1F	
	Subtotal		**3**	

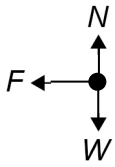
	Question total		**5**	

Q	Marking instructions	AO	Marks	Typical solution
8(a)	Obtains $10mu$	1.1b	B1	$4mu + 6mu = 10mu$
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
8(b)	Forms a conservation of momentum equation using their expression from part **(a)**.	3.1b	M1	Speed of A after collision $= v_A$ Speed of B after collision $= v_B$ C of M $mv_A + 6mv_B = 10mu$ $v_A + 6v_B = 10u$ NLR $v_B - v_A = 3ue$ $7v_B = 3ue + 10u$ $v_B = \frac{u(3e+10)}{7}$
	Obtains a correct momentum equation.	1.1b	A1	
	Forms a correct equation using Newton's law of restitution.	1.1b	B1	
	Completes a reasoned argument using both conservation of momentum and Newton's law of restitution to obtain the correct speed of B AG	2.1	R1	
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
8(c)	Uses a method to find the velocity of A	1.1a	M1	$v_A + 6v_B = 10u$ $v_A = 10u - \frac{6u(3e+10)}{7}$ $v_A = \frac{10u-18ue}{7}$ $\frac{10u-18ue}{7} < 0$ $\frac{5}{9} < e$ $\frac{5}{9} < e \leq 1$
	Obtains $\frac{10u-18ue}{7}$ ACF	1.1b	A1	
	Uses their expression for v_A and forms the inequality $v_A < 0$ Condone use of $v_A = 0$ or $v_A \leq 0$	3.1b	M1	
	Obtains $\frac{5}{9}$ oe or AWRT 0.56	1.1b	B1	
	Deduces $\frac{5}{9} < e \leq 1$ Condone $\frac{5}{9} < e < 1$	2.2a	R1	
	Subtotal		**5**	

	Question total		**10**	

Q	Marking instructions	AO	Marks	Typical solution
9(a)	Draws a correct force diagram showing weight, normal reaction and friction and no other forces.	1.1b	B1	
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
9(b)	Recalls a correct expression for the acceleration or force towards *O*	1.2	B1	$a = r\omega^2$
	Forms the equation $F = mr\omega^2$ or $F = \frac{mv^2}{r}$	3.3	M1	$F = mr\omega^2$ $0.01 = (0.0036)(0.2)\omega^2$
	Obtains a correct equation in ω or v	1.1b	A1	$\omega = \sqrt{\frac{0.01}{0.0036 \times 0.2}}$
	Obtains $\omega = 3.7$ AWRT 3.7	1.1b	A1	$\omega = 3.7$
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
9(c)	States an appropriate modelling assumption. Eg The coin is modelled as a particle. The radius is the distance to the centre of mass of the coin from *O* No air resistance forces.	3.5a	E1	The coin is modelled as a particle.
	Subtotal		**1**	

	Question total		**6**	

	Question Paper total		**40**	