AS
MATHEMATICS
7356/1

Paper 1

Mark scheme

June 2022

Version: 1.1 Final Mark Scheme

2 2 6 A 7 3 5 6 / 1 / M S

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)

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

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 students showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the student 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.

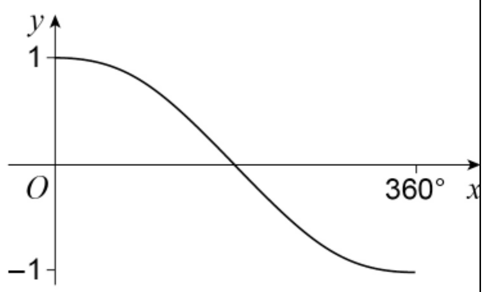
Work erased or crossed out

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.

Q	Marking instructions	AO	Marks	Typical solution
1	Circles correct answer.	1.1b	B1	$\log_{10}\left(\frac{2}{x}\right)$
	Question 1 Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
2	Ticks correct box.	1.1b	B1	
	Question 2 Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
3	Expands at least one term correctly. PI Other terms: $(3x)^4$ + ${}_4C_2(3x)^2\left(\frac{1}{2}\right)^2$ + ${}_4C_3(3x)\left(\frac{1}{2}\right)^3$ + $\left(\frac{1}{2}\right)^4$ Condone use of coefficients only.	1.1a	M1	${}_4C_1\,(3x)^3\left(\frac{1}{2}\right)$
	Selects their x^3 term PI	1.1a	M1	Coefficient = 54
	States correct coefficient.	1.1b	A1	
	Total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
4	Uses identity $\cos^2\theta = 1 - \sin^2\theta$	1.2	B1	$1 - \sin^2\theta = 10\sin\theta + 4$ $0 = \sin^2\theta + 10\sin\theta + 3$ $\sin\theta = -0.3095$ or -9.6904 $\sin\theta = -9.6904$ (not valid) $\sin^{-1}(-0.3095) = -18.03°$ $\theta = 198°$ or $\theta = 342°$
	Solves their quadratic in sinθ PI by at least one correct value of θ or - 18°	1.1a	M1	
	Explains that the second solution or both solutions is/are inappropriate. Accept N/A, out of range, no solutions, math error, reject OE Do not accept a '×' or –9.69 (OE) crossed out alone.	2.4	E1F	
	Obtains one correct value for θ AWRT 198° or 342°	1.1b	A1	
	Obtains two correct values for θ Condone - 18° included, but no other answers.	1.1b	A1	
	Question 4 Total		**5**	

Q	Marking instructions	AO	Marks	Typical solution
5	Obtains $3x^2$ or $a = 3$	1.1b	B1	$(x-2)\,\overline{)3x^3 + 5x^2 - 27x + 10}$ $= 3x^2 + 11x - 5$
	Obtains constant term of – 5 or $c = -5$	1.1b	B1	
	Obtains $11x$ or $b = 11$	1.1b	B1	
	Question 5 Total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
6(a)	Finds correct midpoint of *AB*	1.1b	B1	(4,1)
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
6(b)	Calculates length of radius, *AC*, *BC* or half *AB* using 'their' centre.	3.1a	M1	$r = \sqrt{(4-1)^2 + (1-4)^2}$ $= \sqrt{18}$ $(x-4)^2 + (y-1)^2 = 18$ $x^2 - 8x + 16 + y^2 - 2y + 1 = 18$ $x^2 + y^2 - 8x - 2y = 1$
	Obtains correct value for the radius or square of the radius.	1.1b	A1	
	Derives circle equation in any form using their centre and radius. Condone sign error in brackets. Or Completes the square on given equation to obtain centre and radius. Condone sign error in brackets.	1.1a	M1	
	Completes reasoned argument to obtain equation in given form Or Justifies that the centre and radius obtained from completing the square on the given equation corresponds to the midpoint from part (a) and the radius from part (b) AG	2.1	R1	
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
6(c)	Substitutes y = 0 into the given formula and solves the quadratic equation. Or Uses Pythagoras on the triangle CDM where M(4 , 0) to find DM or EM	3.1a	M1	$x^2 - 8x - 1 = 0$ x = 4 + √17 and 4 – √17 DE = 2√17 Area = ½ × 1 × 2√17 =√17
	Obtains 2 correct values for x Condone decimal equivalents AWRT 8.1 and – 0.1 Or Obtains DM or EM = √17	1.1b	A1	
	Deduces length of DE as the difference between their two values of x Or Deduces the length of DE as twice the length of DM or EM PI	2.2a	M1	
	Obtains √17 CAO	1.1b	A1	
	Subtotal		**4**	

	Question 6 Total		**9**	

Q	Marking instructions	AO	Marks	Typical solution
7	Integrates with at least one term correct.	3.1a	M1	$a^2 - x^2 = 0$ $(a + x)(a - x) = 0$ $x = -a$ or a $\int_{-a}^{a} (a^2 - x^2)dx = 36$ $\left[a^2x - \frac{x^3}{3}\right]_{-a}^{a} = 36$ $a^3 - \frac{a^3}{3} + a^3 - \frac{a^3}{3} = 36$ $\frac{4a^3}{3} = 36$ $a^3 = 27$ $a = 3$
	Obtains correct integral.	1.1b	A1	
	Obtains $x = -a$ or a	1.1b	B1	
	Substitutes their limits into their two-term integrated expression Do not allow any limits involving x	1.1a	M1	
	Equates their expression in terms of a With limits $-a$ to a, to 36 Or With limits 0 to a or $-a$ to 0, to 18	3.1a	M1	
	Completes a reasoned argument to obtain $a = 3$	2.1	R1	
	Question 7 Total		**6**	

Q	Marking instructions	AO	Marks	Typical solution
8(a)	Differentiates, at least one term correct.	1.1a	M1	$\frac{dy}{dx} = 3x^2 - 6 - \frac{9}{x^2}$ For stationary point $\frac{dy}{dx} = 0$ $3x^2 - 6 - \frac{9}{x^2} = 0$ $3x^4 - 6x^2 - 9 = 0$ $x^4 - 2x^2 - 3 = 0$
	Obtains correct derivative.	1.1b	A1	
	Sets correct derivative = 0 and rearranges to obtain given equation.	2.1	R1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
8(b)	Factorises or solves using calculator. PI	1.1a	M1	$(x^2 - 3)(x^2 + 1) = 0$ $(x^2 - 3) = 0$ gives stationary points at $\pm\sqrt{3}$ $(x^2 + 1) = 0$ has no real solutions so there are only two stationary points
	Obtains two correct factors or obtains two correct solutions. ACF	1.1b	A1	
	Concludes that as there are only 2 solutions, there are only 2 stationary points. OE	2.2a	R1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
8(c)	Differentiates their $\frac{dy}{dx}$ again, at least one of the two non-zero terms correct, or uses values to test the sign of $\frac{dy}{dx}$ close to their $\pm\sqrt{3}$ OE	1.1a	M1	$\frac{d^2y}{dx^2} = 6x + \frac{18}{x^3}$ At $(\sqrt{3}, 0)$ $\frac{d^2y}{dx^2}$ is positive therefore this is a minimum point At $(-\sqrt{3}, 0)$ $\frac{d^2y}{dx^2}$ is negative therefore this is a maximum point
	Makes consistent deduction about the nature of one of their stationary points from sign of their $\frac{d^2y}{dx^2}$ or the sign of $\frac{dy}{dx}$ close to their $\pm\sqrt{3}$	1.1a	M1	
	States correct coordinates for one stationary point. ACF	1.1b	B1	
	Obtains the correct exact coordinates of both stationary points, along with their correct natures (from correct $\frac{d^2y}{dx^2}$)	1.1b	A1	
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
8(d)	Deduces $y = 0$	2.2a	B1	$y = 0$
	Subtotal		**1**	

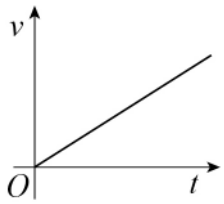
	Question 8 Total		**11**	

Q	Marking instructions	AO	Marks	Typical solution
9	States algebraic expressions for two distinct non-consecutive odd numbers.	3.1a	M1	Let $n = 2p + 1$ $m = 2q + 1$ Where p and q are integers $m^2 + n^2 = (2p + 1)^2 + (2q + 1)^2$ $= 4p^2 + 4p + 1 + 4q^2 + 4q + 1$ $= 2(2p^2 + 2q^2 + 2p + 2q + 1)$ Factor 2 shows it is a multiple of 2 Factor $(2p^2 + 2q^2 + 2p + 2q + 1)$ is 1 more than a multiple of 2 so $m^2 + n^2$ is not a multiple of 4
	Expands their two-termed expression for m and n in $m^2 + n^2$	1.1a	M1	
	Obtains their correct expanded expression. Do not allow if substitutions define the same odd number.	1.1b	A1F	
	Concludes correctly that the expression is a multiple of 2 Do not allow if substitutions define consecutive odd numbers or substitutions which generate the same odd number.	2.4	E1	
	Completes a reasoned argument to conclude correctly the expression is not a multiple of 4. CAO OE Must not have used substitutions which involve m or n or define consecutive odd numbers or which generate the same odd number. CAO	2.1	R1	
	Question 9 Total		**5**	

Q	Marking instructions	AO	Marks	Typical solution
10(a)	Rewrites the equation as $y = \sqrt{2}\,x^{-2}$ PI by correct derivative.	1.1b	B1	$y = \sqrt{2}\,x^{-2}$ $\frac{dy}{dx} = -\frac{2\sqrt{2}}{x^3}$ Grad at $(2, \frac{\sqrt{2}}{4}) = -\frac{2\sqrt{2}}{8} = -\frac{\sqrt{2}}{4}$ Tangent at $(2, \frac{\sqrt{2}}{4})$ is $y - \frac{\sqrt{2}}{4} = -\frac{\sqrt{2}}{4}(x - 2)$ $y = \frac{3\sqrt{2}}{4} - \frac{x\sqrt{2}}{4}$
	Differentiates with their power of x correct provided original power is negative.	1.1a	M1	
	Substitutes $x = 2$ to obtain correct gradient.	1.1b	A1	
	Obtains correct equation of tangent to curve, any form.	1.1b	A1	
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
10(b)	Eliminates y for their tangent and the given curve to find other intersection point. Or Equates $\frac{dy}{dx}$ to the gradient of the perpendicular to their tangent.	3.1a	M1	Meets $y = \frac{\sqrt{2}}{x^2}$ when $\frac{\sqrt{2}}{x^2} = \frac{3\sqrt{2}}{4} - \frac{x\sqrt{2}}{4}$ $\frac{1}{x^2} = \frac{3}{4} - \frac{x}{4}$ $x^3 - 3x^2 + 4 = 0$ $(x-2)^2(x+1) = 0$ Other intersection is at $x = -1$ $\frac{dy}{dx} = \frac{-2\sqrt{2}}{(-1)^3} = 2\sqrt{2}$ $2\sqrt{2} \times (-\frac{\sqrt{2}}{4}) = -1$ Perpendicular to curve so normal
	Simplifies to obtain correct cubic equation. PI by $x = -1$ Or Obtains correct equation $-\frac{2\sqrt{2}}{x^3} = 2\sqrt{2}$ (OE)	1.1a	A1	
	Finds other intersection value of $x = -1$	1.1b	A1	
	Substitutes x = -1 to obtain the correct gradient at the other intersection point. Or Obtains $y = \sqrt{2}$ at the other intersection point.	1.1b	B1	
	Completes a reasoned argument to show the required result using the perpendicular gradients condition. Or Completes argument by finding the equation of the line with gradient $-\frac{\sqrt{2}}{4}$ passing through $(-1, \sqrt{2})$ and verifying that this equation is identical to the equation found in part (a). OE	2.1	R1	
	Subtotal		**5**	

	Question 10 Total		**9**	

Q	Marking instructions	AO	Marks	Typical solution
11	Circles correct graph.	2.2a	B1	
	Question 11 Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
12	Circles correct answer.	1.1b	B1	$15g$ N
	Question 12 Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
13	Finds the vector $\overrightarrow{AB}$ with at least one component correct PI by the modulus calculation ACF	1.1a	M1	$\overrightarrow{AB}$ =5**i** + 12**j**
	Uses Pythagoras to determine their $\lvert\overrightarrow{AB}\rvert$ Condone notation errors for modulus.	1.1a	M1	$\lvert\overrightarrow{AB}\rvert = \sqrt{5^2 + 12^2} = 13$
	Finds the correct force vector. Condone missing units. ACF	1.1b	A1	So $\boldsymbol{F} = \frac{6.5}{13}$(5**i** + 12**j**) 2.5**i** + 6**j** N
	Question 13 Total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
14	Identifies consistent values for u, a and s Do not condone numerical value of g unless recovered later. PI	3.4	B1	$u = 0,\ v = 10,\ a = g$ and $s = h$ $v^2 \leq 100$
	Selects appropriate constant acceleration equation and substitutes their values of u, a and s, allow numerical value of g here (accept equality or inequality at this stage). Condone v^2 not substituted for.	1.1a	M1	$100 \geq 0^2 + 2gh$ $2gh \leq 100$
	Completes reasoned argument to justify the given inequality. AG	2.1	R1	$h \leq \dfrac{50}{g}$
	Question 14 Total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
15(a)	Uses trigonometry to find angle above **i** for path of *Q* PI by 51° (AWRT) or 75° (AWRT)	1.1a	M1	Q angle = $\tan^{-1}\left(\frac{15}{8}\right)$
	Obtains correct angle AWRT 62°	1.1b	A1	Angle between paths = 62°
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
15(b)	Obtains m = 0.8	3.1b	B1	
	Uses $F = ma$ for Q for their m ACF	1.1a	M1	$4 = 5m \implies m = 0.8$ kg $\sqrt{8^2 + 15^2} = 17$
	Obtains a = 21.25 Condone missing units CAO	1.1b	A1	$17 = 0.8a \implies a = 21.25$ m s^{-2}
	Subtotal		**3**	

	Question 15 Total		**5**	

Q	Marking instructions	AO	Marks	Typical solution
16(a)	Uses appropriate constant acceleration equation to find expression for displacement of Jermaine t seconds after acceleration begins, with at least one term correct.	3.1b	M1	Jermaine's displacement
	Obtains fully correct equation for Jermaine's displacement PI $s = (u - 0.2)t + 0.5 \times 2t^2$ Or $s = (u - 0.2)t + 0.5 \times 2t^2 - d$	1.1b	A1	$s = (u - 0.2)t + 0.5 \times 2t^2$ Reaches Meena when $s = ut + d$
	Forms a correct expression for Meena's displacement. $s = ut$ or $s = ut + d$ Do not accept $ut - d$	3.1b	B1	$ut + d = (u - 0.2)t + t^2$ $ut + d = ut - 0.2t + t^2$ $d = t^2 - 0.2t$
	Completes reasoned argument to obtain given result. AG	2.1	R1	
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
16(b)	Uses appropriate constant acceleration equation to find value for t	3.1b	M1	$7.8 = (1.4 - 0.2) + 2t$
	Uses given equation to find correct value of d Accept 10.2 or 10.23	1.1b	A1	$t = 3.3 \Rightarrow d = 10.23$
	Subtotal		**2**	

	Question 16 Total		**6**	

Q	Marking instructions	AO	Marks	Typical solution
17(a)	Differentiates to find expression for acceleration with at least one term correct.	3.4	M1	$a = 0.5 + 0.02t$
	Substitutes t = 15 to obtain $a = 0.8$ Or Shows that when a = 0.8, t = 15 AG	1.1b	A1	$a = 0.5 + 0.02 \times 15 = 0.8$
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
17(b)(i)	Uses $F = ma$ to form an equation with three-terms modelling the caravan.	3.3	M1	$800 - R = 850 \times 0.8$
	Obtains 120 N Condone missing units.	1.1b	A1	$R = 120$ N
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
17(b)(ii)	Uses $F = ma$ to form equation modelling the car or the whole system with one side correct. Whole system equation is $D - 220 = 2350(0.8)$	3.3	M1	$D - 800 - 100 = 1500 \times 0.8$
	Forms fully correct equation.	1.1b	A1	
	Obtains 2100 N Condone missing units.	1.1b	A1	$D = 2\,100$ N
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
17(c)	States a valid assumption about the tow bar. Accept • Inelastic/inextensible OE • Light OE • Rigid • Tension is constant throughout the tow bar • Tow bar is in the direction of the car and caravan • Tow bar is horizontal Do not accept 'the tow bar breaks' or 'uniform'.	3.5b	B1	Tow bar is light
	Subtotal		**1**	

	Question 17 Total		**8**	

	Question Paper Total		**80**	