
AS
MATHEMATICS
7356/2

Paper 2

Mark scheme

June 2022

Version: 1.0 Final Mark Scheme



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.

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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	$3x^4 + c$
Question 1 Total			1	

Q	Marking instructions	AO	Marks	Typical solution
2	Circles correct answer	1.1b	B1	320°
Question 2 Total			1	

Q	Marking instructions	AO	Marks	Typical solution
3	Uses fractional power to represent square root PI by $\frac{dy}{dx}$ involving $x^{-\frac{1}{2}}$	1.2	B1	$y = k\sqrt{x} = kx^{\frac{1}{2}}$
	Differentiates to obtain an expression in $x^{-\frac{1}{2}}$ or $\frac{1}{\sqrt{x}}$	1.1a	M1	$\frac{dy}{dx} = \frac{k}{2}x^{-\frac{1}{2}}$
	Obtains fully correct expression for $\frac{dy}{dx}$	1.1b	A1	$\frac{d^2y}{dx^2} = -\frac{k}{4}x^{-\frac{3}{2}}$
	Differentiates to obtain an expression in $x^{-\frac{3}{2}}$ or $\frac{1}{x\sqrt{x}}$ OE	1.1a	M1	At $(4, 2k) \frac{d^2y}{dx^2} = -\frac{k}{32}$
	Obtains $-\frac{k}{32}$ seen anywhere following a correct $\frac{d^2y}{dx^2}$	1.1b	A1	
Question 3 Total			5	

Q	Marking instructions	AO	Marks	Typical solution
4	Recalls that the discriminant must be negative, seen anywhere in solution	1.2	B1	<p>For no real solutions the discriminant must be negative</p> $4^2 - 4 \times 9 \times p^2 < 0$ $p^2 > \frac{4}{9}$ $p > \frac{2}{3} \text{ or } p < -\frac{2}{3}$
	Substitutes 9, 4 and p^2 into the expression $b^2 - 4ac$ PI	1.1a	M1	
	Deduces correct critical values of $\frac{2}{3}$ and $-\frac{2}{3}$	2.2a	A1	
	Obtains two correct inequalities for p	2.5	A1	
Question 4 Total			4	

Q	Marking instructions	AO	Marks	Typical solution
5(a)	Shows that 3 has been substituted and $f(3) = 0$ and states that Kaya is correct OE	2.4	E1	$f(3) = 54 - 63 - 36 + 45 = 0$ Kaya is correct that $f(3) = 0$
	States that Kaya is incorrect and gives the correct conclusion Kaya should have reached Or States that Kaya is incorrect and that $f(-3) \neq 0$ Or States that Kaya is incorrect and provides evidence that $(x + 3)$ is not a factor of $f(x)$	2.3	E1	But Kaya's conclusion is wrong $(x - 3)$ is a factor of $f(x)$
	Subtotal		2	

Q	Marking instructions	AO	Marks	Typical solution
5(b)	Divides $f(x)$ by $x - 3$ or $x + 3$ or uses inspection. Must obtain $2x^2$ or 15 or finds another root of $f(x) = 0$	1.1a	M1	$(2x^3 - 7x^2 - 12x + 45) / (x - 3)$ $= 2x^2 - x - 15$
	Finds correct quadratic factor or both remaining roots of $f(x) = 0$	1.1b	A1	$(x - 3)^2(2x + 5)$
	Factorises $f(x)$ correctly ISW	1.1b	A1	
	Subtotal		3	

	Question 5 Total		5	
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Q	Marking instructions	AO	Marks	Typical solution
6(a)	Obtains 57 AFWW 56 to 57	3.3	B1	$16\ln 5 + 31 = 57$ years
Subtotal			1	

Q	Marking instructions	AO	Marks	Typical solution
6(b)	Uses exponential as inverse of logarithm PI by correct value of 'x' Condone use of $10^{\frac{9}{16}}$ for M1	1.1a	M1	$\ln x = \frac{40-31}{16}$ $x = e^{\frac{9}{16}}$ $x = 1.755$ $= 21 \text{ months}$
	Calculates the correct value of 'x', AFWW 1.75 to 1.76 Or FT 'x' = 3.65 from using $10^{\frac{9}{16}}$, AFWW 3.65 to 3.66	3.4	A1F	
	Obtains 21 months or 1 year 9 months Or FT Accept 3 years 8 months or 44 months	3.2a	A1F	
Subtotal			3	

Q	Marking instructions	AO	Marks	Typical solution
6(c)	States what happens to a logarithm for values approaching zero or gives appropriate example	3.5b	E1	As x approaches zero $\ln(x)$ becomes negative
	States the consequence for the dog's equivalent human age as the dog's age approaches zero	3.5a	E1	As the dog age approaches zero the equivalent human age can become negative
Subtotal			2	

Question 6 Total			6	
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Q	Marking instructions	AO	Marks	Typical solution
7	Recalls that correct step is to multiply top and bottom by $2 - \sqrt{n}$ PI by subsequent work	1.2	M1	$\frac{3 - \sqrt{n}}{2 + \sqrt{n}} \times \frac{2 - \sqrt{n}}{2 - \sqrt{n}}$
	Multiplies numerator and denominator by $(2 - \sqrt{n})$ to get correct terms (condone sign errors) Does not need to be simplified PI by correct simplification	1.1a	M1	$\frac{6 - 3\sqrt{n} - 2\sqrt{n} + n}{4 + 2\sqrt{n} - 2\sqrt{n} - n}$
	Obtains correct simplified numerator and denominator not necessarily in a fraction	1.1b	A1	$\frac{6 + n - 5\sqrt{n}}{4 - n}$
	States correct expressions for a and b Or gives expression with a and b correctly identified	1.1b	A1	$a = \frac{6 + n}{4 - n}$ $b = \frac{-5}{4 - n}$
Question 7 Total			4	

Q	Marking instructions	AO	Marks	Typical solution
8(a)(i)	Explains that $(m + n)$ is the largest side (which must be opposite the largest angle)	2.4	E1	The largest angle must be opposite the largest side which is $(m + n)$
Subtotal			1	

Q	Marking instructions	AO	Marks	Typical solution
8(a)(ii)	Substitutes for a, b, c into cosine rule	1.1a	M1	$(m + n)^2 = m^2 + (m - n)^2 - 2m(m - n)\cos A$ $\cos A = \frac{m^2 + (m - n)^2 - (m + n)^2}{2m(m - n)}$ $\cos A = \frac{m^2 - 4mn}{2m(m - n)}$ $\cos A = \frac{m - 4n}{2(m - n)}$
	Makes $\cos A$ the subject	1.1a	M1	
	Completes reasoned argument to obtain given result. AG	2.1	R1	
Subtotal			3	

Q	Marking instructions	AO	Marks	Typical solution
8(b)	Deduces that A is 90° , Accept marked on diagram PI by awarding of M1	2.2a	B1	$A \text{ must be } 90^\circ$ $\text{So } \cos A = 0$ $\frac{m - 4n}{2(m - n)} = 0$ $m = 4n$ $n = 2$
	Substitutes $\cos A = 0$ in part (a) equation PI by correct value for n Or uses Pythagoras	3.1a	M1	
	Obtains $n = 2$	1.1b	A1	
Subtotal			3	

Question 8 Total			7	
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Q	Marking instructions	AO	Marks	Typical solution
9(a)	Deduces one correct inequality related to the sloping line or the curve. Condone strict inequalities	2.2a	B1	$y \leq x + 2$ $y \geq x^2 - 4x - 12$ $y \geq 0$
	Deduces the other two correct inequalities Condone strict inequalities	2.2a	B1	
	Subtotal		2	

Q	Marking instructions	AO	Marks	Typical solution
9(b)	States x coordinate of A is -2	1.1b	B1	$A \text{ is } (-2, 0)$ $B \text{ is } (6, 0)$ $x + 2 = x^2 - 4x - 12$ $x^2 - 5x - 14 = 0$ $(x + 2)(x - 7) = 0$ $C \text{ is point } (7, 9)$
	States x coordinate of B is 6	1.1b	B1	
	Eliminates y to obtain x coordinate of $C = 7$	1.1a	M1	
	Obtains correct y coordinates of A, B and C	1.1b	A1	
	Subtotal		4	

Q	Marking instructions	AO	Marks	Typical solution
9(c)	Obtains correct value for area under AC	1.1b	B1	Area of triangle under AC $= 0.5 \times 9 \times 9$ $= 40.5$ Area below BC $= \int_6^7 (x^2 - 4x - 12) dx$ $= \left[\frac{x^3}{3} - 2x^2 - 12x \right]_6^7$ $= \frac{343}{3} - 98 - 84 - 72 + 72 + 72$ Shaded area $= 40.5 - 4\frac{1}{3}$ $= 36\frac{1}{6}$
	Integrates a quadratic expression with $\frac{x^3}{3}$ term correct PI by $\frac{13}{3}$ ACF	1.1a	M1	
	Integrates $x^2 - 4x - 12$ completely correct Condone inclusion of + c here PI by $\frac{13}{3}$ ACF Condone integration of $x^2 - 5x - 14$ correctly	1.1b	A1	
	Substitutes a pair of limits into their integrated quadratic, must be three terms, including subtraction. PI by $\frac{13}{3}$ ACF	1.1a	M1	
	Uses a correct method to combine areas that lead to the exact area of the shaded region	3.1a	M1	
	Obtains $36\frac{1}{6}$ or $\frac{217}{6}$ ISW	2.1	R1	
	Subtotal		6	

Question 9 Total	12
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Q	Marking instructions	AO	Marks	Typical solution
10(a)	Obtains 14	3.3	B1	$a = 14$
	Subtotal		1	

Q	Marking instructions	AO	Marks	Typical solution
10(b)	Substitutes 12 and 10 into given equation	3.4	M1	$12 = 20 - 14e^{-10k}$ $k = 0.056$
	Forms a fully correct equation FT their value for a	1.1a	A1F	
	Obtains correct value of k AWRT	1.1b	A1	
	Subtotal		3	

Q	Marking instructions	AO	Marks	Typical solution
10(c)	Substitutes their k and other values correctly into given model	3.4	B1	$18 = 20 - 14e^{-0.056t}$ $t = 35 \text{ minutes}$
	Solves their model equation to obtain a value for t , where $t > 10$	1.1a	M1	
	Obtains correct value of t including units AWRT 35	3.2a	A1	
	Subtotal		3	

Q	Marking instructions	AO	Marks	Typical solution
10(d)	Explains that the conditions may change. Eg. Someone may have drunk the water OE OR states that after 3 hours the water will be effectively at room temperature.	3.5b	E1	It is not likely that the room temperature will stay at 20°C over such a long period
	Subtotal		1	

	Question 10 Total		8	
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Q	Marking instructions	AO	Marks	Typical solution
11	Circles correct answer	2.5	B1	Negatively skewed
Question 11 Total			1	

Q	Marking instructions	AO	Marks	Typical solution
12	Circles correct answer	2.2a	B1	Cluster
Question 12 Total			1	

Q	Marking instructions	AO	Marks	Typical solution
13(a)	States mean = 0.026 AWRT	1.1b	B1	Mean = 0.026
	States the correct standard deviation AWRT 0.021 or 0.022	1.1b	B1	Standard deviation = 0.021
Subtotal			2	

Q	Marking instructions	AO	Marks	Typical solution
13(b)(i)	Finds 'their' % drop Or calculates 'their' mean as a % of 0.122 Or calculates 25% or 75% of 0.122 (= 0.0305 or 0.0915) ...	1.1a	M1	$\% \text{ drop} = \frac{(0.122 - 0.026)}{0.122} \times 100$ $= 78.7\%$
	Compares 'their' 79% to 75 Or compares 'their' 21% to 25 Or ...and shows that 'their' mean < 0.0305 or (0.122 – 'their' mean) > 0.0915	2.2b	A1F	78.7% > 75%
Subtotal			2	

Q	Marking instructions	AO	Marks	Typical solution
13(b)(ii)	Makes one appropriate comment on the validity of the claim	2.4	E1	The LDS only includes a limited number of makes of car so cannot make a claim about all makes of cars
	Makes a second (different) comment on the validity of the claim Also accept: This is too small a sample to make any significant comment about the change in NOX emissions Limited NOX emission data in LDS	2.4	E1	The LDS does not include cars from all areas of the UK so cannot make a claim about cars from all areas of the UK
Subtotal			2	

Question 13 Total			6	
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Q	Marking instructions	AO	Marks	Typical solution
14(a)	Uses $1 - P(\text{no bananas})$ (at least $1 - p^4$ for $0 < p < 1$ seen) or Uses $P(1) + P(2) + P(3) + P(4)$ Or Uses $P(x \geq 1)$ using $B(4, 0.35)$	3.1b	M1	$P(\text{at least 1 banana})$ $= 1 - P(\text{no bananas})$ $= 1 - 0.65^4$
	Obtains correct probability AWFW 0.821 to 0.822 Accept 0.82	1.1b	A1	$= 0.82149$
Subtotal			2	

Q	Marking instructions	AO	Marks	Typical solution
14(b)	Calculates the correct three terms, not necessarily evaluated and not necessarily added	3.1b	M1	$0.2^4 + 0.35^4 + 0.45^4$
	Obtains correct answer (AWRT 0.058)	1.1b	A1	$= 0.0576125$
Subtotal			2	

Q	Marking instructions	AO	Marks	Typical solution
14(c)	Uses 0.2^2 or 0.45^2 anywhere or fraction equivalents	1.1b	B1	$P(\text{apple twice and cake twice})$
	Uses $(k \times) 0.2^2 \times 0.45^2 (\times 0.35^0)$ or fraction equivalents and no other terms PI by correct answer	3.1b	M1	$= 6 \times 0.2^2 \times 0.45^2$
	Obtains correct answer CAO	1.1b	A1	$= 0.0486$
Subtotal			3	

Question 14 Total			7	
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Q	Marking instructions	AO	Marks	Typical solution
15(a)	Obtains $9k$	1.1b	B1	$9k$
	Subtotal		1	

Q	Marking instructions	AO	Marks	Typical solution
15(b)	Uses probabilities c , $2c$, $9k$, $16k$	1.1b	B1	$c + 2c + 9k + 16k = 1$ $3c + 25k = 1$ $9k + 16k = 3(c + 2c)$ $25k = 9c$ $c = \frac{1}{12}$ $k = \frac{3}{100}$
	Uses $\Sigma p = 1$ to obtain an equation in k and c , at least one term in k or c correct or Uses ratio of 1:3(:4) to obtain an equation either in c related to 0.25 or in k related to 0.75. At least one term in k or c correct [$c + 2c = 0.25$; $9k + 16k = 0.75$]	3.1a	M1	
	Uses ratio of 1:3 to find an equation in k and c , at least one term in k or c correct or Obtains a second equation in k or c using the ratio of 1:3(:4), at least one term in k or c correct	1.1a	M1	
	Obtains correct exact values for k and c (ACF but must be exact)	1.1b	A1	
	Subtotal		4	

	Question 15 Total		5	
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Q	Marking instructions	AO	Marks	Typical solution
16(a)(i)	Obtains correct answer from model AWRT 0.247 Accept 0.25 and %	3.4	B1	0.24706
Subtotal			1	

Q	Marking instructions	AO	Marks	Typical solution
16(a)(ii)	Obtains correct mean (CAO) Do not ISW	1.1b	B1	Mean = np = 7×0.7 = 4.9
Subtotal			1	

Q	Marking instructions	AO	Marks	Typical solution
16(b)	States both hypotheses correctly for a one-tailed test. Accept population proportion for p. Accept 70%, but not $H_0 = 0.7$ or $x =$ or $\bar{x} =$ or $\mu =$	2.5	B1	Y is 'No of times the coin lands heads' $H_0: p = 0.7$ $H_1: p > 0.7$
	States model used (PI by AWRT 0.13, 0.068, 0.038, 0.065, 0.87 Or critical region >28)	3.3	M1	Under $H_0: Y \sim B(35, 0.7)$
	Evaluates $P(Y \geq 28)$ using calculator = 0.13 (AWRT) OE	1.1b	A1	$P(Y \geq 28) = 1 - P(Y \leq 27)$ = $1 - 0.86735 \dots$ = 0.13265 = 0.133
	Compares 0.13 to 0.1 Or 0.87 to 0.9 Or 28 to justified critical region of 29 or more And makes appropriate inference	2.2b	A1	As $0.133 > 0.1$ Accept H_0
	Concludes correctly in context CSO 'insufficient evidence' OE required. Only award for full complete correct solution.	3.2a	R1	There is insufficient evidence to suggest that the probability of getting a head is more than 0.7.
Subtotal			5	

Question 16 Total			7	
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Question Paper Total			80	
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