AS
MATHEMATICS
7356/2

Paper 2

Mark scheme

June 2021

Version: 1.0 Final Mark Scheme

216A7356/2/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.

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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 or m marks and is for accuracy
B	mark is independent of M or 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
SCA	substantially correct approach
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.

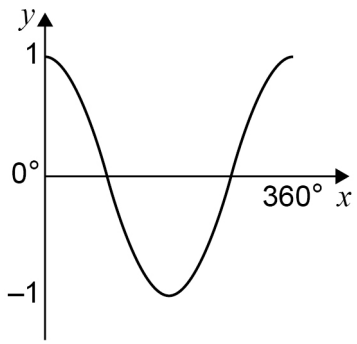
Work erased or crossed out

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	$a^{\frac{3}{2}}$
	Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
2	Ticks correct box	2.2a	B1	
	Total		**1**	

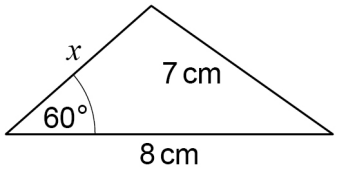
Q	Marking instructions	AO	Marks	Typical solution
3	Rewrites $\sqrt{x}$ as $x^{\frac{1}{2}}$	1.1b	B1	$\frac{dy}{dx} = x^{\frac{1}{2}}$ $y = \frac{2}{3}x^{\frac{3}{2}} + c$
	Integrates their x^k for non-integer k to obtain x^{k+1}	1.1a	M1	
	Obtains $y = \frac{2}{3}x^{\frac{3}{2}} + c$ Condone no constant of integration or numerical value for c used	1.1b	A1	
	Total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
4(a)	Expands, at least first term and one other term correct	1.1a	M1	$1 + 5 \times (-2x) + \frac{5 \times 4}{2}(-2x)^2$
	Expands with all terms correctly simplified	1.1b	A1	$= 1 - 10x + 40x^2$
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
4(b)	Correctly expands $(1 + 5x)^2$	1.1a	M1	$(1 + 5x)^2 = 1 + 10x + 25x^2$
	Obtains correct simplified expression for their $(1 – 2x)^5 + (1 + 5x)^2$	1.1b	A1F	$2 + 65x^2$
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
4(c)	Obtains $x = 0.001$ as the value to use	3.1a	M1	Use $x = 0.001$
	Obtains 2.000065 CSO	1.1b	A1	$2 + 65 \times 0.001^2$ $= 2.000\,065$
	Subtotal		**2**	

	Question Total		**6**	

Q	Marking instructions	AO	Marks	Typical solution
5(a)	Uses cosine rule or sine rule correctly to obtain any unknown angle or length	1.1b	B1	
	Uses the cosine rule to find an expression for, or the length of, AC	1.1a	M1	Using cosine rule $7^2 = 8^2 + x^2 - 2 \times 8 \times x \times \cos 60$ $x^2 - 8x + 15 = 0$
	Deduces that *AC* = 5cm (AWRT) Condone missing or incorrect units	2.2a	R1	$x = 3$ or 5 *AC* = 5cm
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
5(b)	States *AD* = 3cm Condone missing or incorrect units	1.1b	B1	*AD* = 3cm
	Subtotal		**1**	

	Question Total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
6	Takes logs to base 5 of both sides. Condone use of any base.	1.1a	M1	Take logs $2x + 4 = \log_5 9$ $2x + 4 = 2\log_5 3$ $x = -2 + \log_5 3$
	Writes $\log_a 9$ as $2\log_a 3$ OE	1.1b	B1	
	Obtains correct simplified answer PI by a = - 2 and b = 3	1.1b	A1	
	Total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
7(a)	States correct coordinates of *B* or *C* Or States the correct x coordinates of B **and** C	1.1a	M1	*A* is (0, 2) *B* is (1, 0) *C* is (2, 0)
	Obtains A(0 , 2), B(1 , 0) and C(2 , 0)	1.1b	A1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
7(b)(i)	Integrates in two parts with limits *O* to *B* and *B* to *C*	3.1a	M1	$\int_0^1 (x^2 - 3x + 2)\,\mathrm{d}x$
	Integrates quadratic function with at least one term correct	1.1a	M1	$= [\frac{1}{3}x^3 - \frac{3}{2}x^2 + 2x]_0^1$
	Integrates completely correctly	1.1b	A1	$= [\frac{1}{3} - \frac{3}{2} + 2] = \frac{5}{6}$
	Substitutes the two sets of their limits and subtracts the *BC* value from the *OB* value or uses the modulus for the *BC* value	1.1a	M1	$\int_1^2 (x^2 - 3x + 2)\,\mathrm{d}x$ $[\frac{1}{3}x^3 - \frac{3}{2}x^2 + 2x]_1^2$ $[\frac{1}{3} \times 8 - \frac{3}{2} \times 4 + 2 \times 2] - (\frac{5}{6})$
	Completes calculation of total area convincingly to given answer. AG	2.1	R1	$= -\frac{1}{6}$ Total area = $\frac{5}{6} - (-\frac{1}{6}) = 1$
	Subtotal		**5**	

Q	Marking instructions	AO	Marks	Typical solution
7(b)(ii)	Explains that the area between B and C is treated as negative (OE)	2.3	E1	The calculator treats the area between B and C as negative.
	Subtotal		**1**	

	Question Total		**8**	

Q	Marking instructions	AO	Marks	Typical solution
8	Substitutes $(x+h)$ into $f(x+h) - f(x)$ Condone one slip	1.1a	M1	$\lim_{h\to 0}\left[\frac{3(x+h)-5(x+h)^2-(3x-5x^2)}{h}\right]$ $\lim_{h\to 0}\left[\frac{3x+3h-5x^2-10xh-5h^2-3x+5x^2}{h}\right]$ $\lim_{h\to 0}\left[\frac{3h-10xh-5h^2}{h}\right]$ $\lim_{h\to 0}[3-10x-5h]$ $\frac{dy}{dx} = 3-10x$
	Obtains correct expanded expression for $f(x+h) - f(x)$	1.1b	A1	
	Divides each term in their numerator by h	1.1a	M1	
	Completes rigorous mathematical argument to show the required result. Must see $\lim_{h\to 0}$	2.1	R1	
	Total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
9(a)	States correct factorisation	1.1b	B1	$n^3 - n = n(n^2 - 1)$ $= n(n-1)(n+1)$
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
9(b)	States that $(n-1)$, n, $(n+1)$ are 3 consecutive integers. Or States that all integers are either a multiple of 3 or 1 more or less than a multiple of 3	3.1a	E1	$(n-1)\ n\ (n+1)$ is the product of three consecutive integers So one must be a multiple of 3 And at least one must be a multiple of 2 So the product has factors of 2 and 3, so is a multiple of $2 \times 3 = 6$
	Deduces that one of these factors must be a multiple of 3 (PI) Or Deduces that one of these factors must be a multiple of 2. Condone 'even' for implied multiple of 2.	2.2a	E1	
	States that at least one must be a multiple of 2 (even), one must be a multiple of 3 and draws correct conclusion.	2.1	R1	
	Subtotal		**3**	

	Question Total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
10(a)	Uses side of box is $30 - 2x$	3.1b	M1	$C = x(30 - 2x)^2$ $= x(900 - 120x + 4x^2)$ $C = 900x - 120x^2 + 4x^3$
	Identifies the three dimensions then expands correctly to obtain answer AG	2.1	R1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
10(b)	Differentiates, at least one term correct	1.1a	M1	$\frac{dC}{dx} = 900 - 240x + 12x^2$
	Obtains correct derivative	1.1b	A1	For maximum $\frac{dC}{dx} = 0$
	Explains $\frac{dC}{dx}$ must be 0 for turning point (or maximum)	2.4	E1	$x = 5$ or 15 however $x < 15$ therefore $x = 5$
	Equates their derivative to 0 and solves to find a value of $x < 15$	1.1a	M1	$\frac{d^2C}{dx^2} = -240 + 24x$ Negative when $x = 5$
	Obtains $x = 5$	1.1b	A1	So maximum at $x = 5$, $C = 2000\text{cm}^3$
	Justifies $x = 5$ is the maximum	2.1	R1	
	States maximum capacity CAO Condone incorrect or missing units	3.2a	A1	
	Subtotal		**7**	

	Question Total		**9**	

Q	Marking instructions	AO	Marks	Typical solution
11(a)(i)	Writes down the equation of the circle in any correct form	1.1b	B1	Circle equation is $(x-0)^2 + (y-10)^2 = (\sqrt{20})^2$
	Substitutes mx for y	1.1a	M1	$x^2 + y^2 - 20y + 100 = 20$ $x^2 + y^2 - 20y + 80 = 0$
	Simplifies to the given quadratic AG	2.1	R1	Substitute $y = mx$ $x^2 + m^2x^2 - 20mx + 80 = 0$ $(1 + m^2)x^2 - 20mx + 80 = 0$
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
11(a)(ii)	Uses the discriminant of the given equation from (a)(i)	3.1a	M1	Using $b^2 = 4ac$ $400m^2 = 4 \times (1 + m^2) \times 80$
	Obtains a correct equation in m	1.1b	A1	$5m^2 = 4 \times (1 + m^2)$ $m^2 = 4$
	Obtains $m = \pm 2$	1.1b	A1	$m = \pm 2$
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
11(b)	Uses one of their m values from **(a)(ii)**	3.1a	M1	Using $m = 2$ in equation from (a) $5x^2 - 40x + 80 = 0$ $x = 4$ giving $y = 8$
	Obtains one correct x value	1.1b	A1	Using $m = -2$ in equation from (a) $5x^2 + 40x + 80 = 0$ $x = -4$ giving $y = 8$
	Uses line equation to calculate y value	1.1a	M1	So (4, 8) and (–4, 8)
	Obtains two correct sets of coordinates	1.1b	A1	
	Subtotal		**4**	

	Question Total		**10**	

Q	Marking instructions	AO	Marks	Typical solution
12	Circles the correct answer	2.2b	B1	Systematic
	Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
13	Circles the correct answer	1.1b	B1	0.58
	Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
14(a)	Uses np to find μ PI by 4.8	1.1a	M1	μ = np = 16 × 0.3 = 4.8 P($T \leq 4.8$) = P($T \leq 4$) = 0.4499
	Obtains the correct probability (AWRT 0.45)	3.4	A1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
14(b)	Finds the correct variance (CAO)	1.1b	B1	Variance = 16 × 0.3 × 0.7 = 3.36
	Subtotal		**1**	

	Question Total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
15(a)(i)	Deduces the correct letter	2.2a	B1	F
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
15(a)(ii)	States an appropriate action to deal with the error	2.4	E1	Remove the point from the set of data
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
15(b)	Indicates somewhere in their response that the scatter diagram does not imply causality (ISW) Or Identifies any counter example from the data and concludes	2.4	E1	The claim is invalid because correlation does not imply causality.
	Subtotal		**1**	

	Question Total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
16(a)	Obtains either 171 or 124 (AWRT)	1.1a	M1	$Mean_{2002} = 171$ $Mean_{2016} = 124$
	Subtracts means to obtain correct difference (AWRT) Or Expresses as a 27% reduction (AWRT)	1.1b	A1	Reduction = 171 – 124 = 47
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
16(b)	Disagrees with the statement and refers to the small number (1 of each) of these types of car in the data set for 2016 not being able to cause such a fall in the mean (OE)	2.4	E1	Disagree with the statement as there are very few cars of these types in the LDS in 2016, so they alone cannot have caused this reduction in the mean emissions
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
16(c)(i)	Shows that the total sample size is 2359 and indicates this is different to the total size of the LDS (3827). Implied by mention of 1468 missing/extra or Total sample size is less than 3827	2.4	E1	The claim is being made because 1215 + 1144 = 2359 ≠ 3827
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
16(c)(ii)	Gives an indication that the LDS also has other categories	2.4	E1	The claim is incorrect because the LDS also has a 'Company' car category
	Subtotal		**1**	

	Question Total		**5**	

Q	Marking instructions	AO	Marks	Typical solution
17(a)(i)	States correct answer (ACF)	1.1b	B1	P(A) = $\frac{100}{200}$ = 0.5
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
17(a)(ii)	States correct answer (ACF)	1.1b	B1	Find P(A' ∩ B) = $\frac{20}{200}$ = 0.1
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
17(a)(iii)	Uses correct formula for P(A U B) with 'their' P(A), P(B) and P(A ∩ B) (≠ 0) (PI by correct answer) Or Counting from the table $\frac{12+8+10+50+30+10}{200}$ Condone double-counting the 10 for A∩B for this mark.	3.1a	M1	P(B) = $\frac{30}{200}$ = 0.15 P(A ∩ B) = $\frac{10}{200}$ = 0.05 P(A U B) = P(A) +P(B) – P(A ∩ B) P(A U B) = 0.5 + 0.15 – 0.05 = 0.6
	Obtains correct answer. (ACF)	1.1b	A1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
17(b)	Calculates P(A) × P(B) for 'their' P(A) and P(B)	3.1a	M1	P(A) × P(B) = 0.5 × 0.15 = 0.075 0.075 ≠ 0.05
	Compares to 'their' P(A ∩ B) (providing P(A ∩ B) ≠ 0) and deduces that the events are not independent	2.2a	A1F	As P(A ∩ B) ≠ P(A) × P(B) Events A and B are not independent
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
17(c)	States any two events which are mutually exclusive, but must be different to events A and B 2 from terraced / semi – detached /apartment Or 1 toilet and 3 toilets Or apartment and 3 toilets	1.1b	B1	Event 1 is the event the property has 1 toilet Event 2 is the event the property has 3 toilets
	Subtotal		**1**	

	Question Total		**7**	

Q	Marking instructions	AO	Marks	Typical solution
18(a)	Explains why this test is a one-tailed test. Must be in context. Condone explanation using 'number of' linked to increase	3.2a	E1	If the campaign is effective, then the proportion of under 30s visitors will be greater than 14%. So, a one-tailed test is required.
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
18(b)	States both hypotheses correctly for a one-tailed test. Accept population proportion for p. Accept 14%, but not x = or $\overline{x}$ = or μ =	2.5	B1	X is 'No of under 30's visitors to the website' H_0: p = 0.14 H_1: p > 0.14 Under H_0: X ~ B(60 , 0.14) P($X \geq 15$) = 1 – P($X \leq 14$) = 1 – 0.98351 … = 0.01649 = 0.0165 As 0.0165 < 0.05 Reject H_0 There is sufficient evidence to suggest that the advertising campaign has been effective.
	States model used (PI by 0.016(5), 0.0071(5), 0.035, 0.0029, 0.0093) (AWRT)	1.1a	M1	
	Evaluates using calculator = 0.016(5) (AWRT) (condone 0.0071(5) for A1)	1.1b	A1	
	Compares 0.016(5) to 0.05 and rejects H_0. (PI)(CSO) No ft here. Must see clear comparison (inequality or diagram)	3.5a	A1	
	Concludes correctly in context CSO 'sufficient evidence' OE required. Only award for full complete correct solution.	3.2a	R1	
	Subtotal		**5**	

Q	Marking instructions	AO	Marks	Typical solution
18(c)	Recalls that the sample would need to be Random. Accept 'not biased' OE	1.2	E1	The sample would need to be a Random sample
	Subtotal		**1**	

	Question Total		**7**	