AS
MATHEMATICS
7356/2

Paper 2

Mark scheme

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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.

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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)
ISW	Ignore Subsequent Workings

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 third answer	1.1b	B1	$\frac{4}{5}$
	Question 1 Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
2	Ticks third box	1.2	B1	$\cos^2 x = 1 - \sin^2 x$
	Question 2 Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
3	Uses power law for logarithms at least once	1.1a	M1	$\log_a x^3 = \log_a 72 - \log_a 3^2$
	Uses subtraction law for logarithms OE PI by $\log_a 8$ OE Condone $\frac{\log_a 72}{\log_a 9}$ if recovered to $\log_a 8$ Condone omission of the base a	1.1a	M1	$\log_a x^3 = \log_a \frac{72}{9} = \log_a 8$ $x^3 = 8$ $x = 2$
	Obtains $\log_a 8$ on right-hand side of equation OE Or $\log_a 9x^3$ on left-hand side Condone omission of the base a	1.1b	A1	
	Obtains $x = 2$ CAO	1.1b	A1	
	Question 3 Total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
4(a)	Obtains $y = 8\sin x + 4$ OE	1.1b	B1	$y = 8\sin x + 4$
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
4(b)	Obtains $y = 32\sin x$ OE	1.1b	B1	$y = 32\sin x$
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
4(c)	Obtains $y = 8\sin\frac{x}{2}$ OE	1.1b	B1	$y = 8\sin\frac{x}{2}$
	Subtotal		**1**	

	Question 4 Total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
5	Evaluates $4n^2 + 3$ for at least one value of n	3.1a	M1	$n = 1$ gives 7 $n = 2$ gives 19 $n = 3$ gives 39 39 = 3 × 13 so not prime
	Obtains one value that is not prime	2.3	A1	
	Shows explicitly that their value factorises.	2.4	R1	
	Question 5 Total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
6(a)	Applies Binomial Expansion formula to x^2 term. At least two of ${}^nC_2$, 3^{n-2} or $(ax)^2$ or a^2 correct.	1.1a	M1	x^2 term = ${}^nC_2\ 3^{n-2}(ax)^2$ $\frac{n(n-1)}{2} \times \frac{3^n}{9} \times a^2 = 4860$ $3^n a^2 n(n-1) = 2 \times 9 \times 4860 = 87480$
	Expresses ${}^nC_2 = \frac{n(n-1)}{2}$ Or 3^{n-2} as $\frac{3^n}{9}$ or $3^n \times 3^{-2}$	1.2	B1	
	Completes reasoned argument to obtain given expression AG	2.1	R1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
6(b)(i)	Verifies that $n = 6$	1.1b	B1	Constant term is 3^n $3^6 = 729$ So $n = 6$
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
6(b)(ii)	Substitutes $n = 6$ into formula from **(a)** Or Obtains ${}^6C_2\ 3^4a^2 = 4860$ PI by $a = 2$ or $a = -2$ or $a^2 = 4$	1.1a	M1	$729a^2 \times 6 \times 5 = 87480$ $a^2 = 4$ $a = \pm 2$ Negative x coefficient so $a = -2$
	Obtains $a^2 = 4$ ACF PI by $a = 2$ or $a = -2$	1.1b	A1	
	Deduces that $a = -2$	2.2a	R1	
	Subtotal		**3**	

	Question 6 Total		**7**	

Q	Marking instructions	AO	Marks	Typical solution
7(a)	Obtains midpoint (–2, 3)	1.1b	B1	Midpoint of AB is (–2, 3) Gradient of AB = $\frac{5-1}{-8-4} = -\frac{1}{3}$ Gradient of perpendicular to AB = 3 Equation is $y - 3 = 3(x + 2)$ $y = 3x + 9$
	Finds the gradient of the line AB Using 5 with 1 divided by −8 with 4 PI by Gradient = $\pm\frac{1}{3}$	1.1a	M1	
	Obtains gradient of AB = $-\frac{1}{3}$ OE	1.1b	A1	
	Applies perpendicular gradient rule to their gradient	1.1a	M1	
	Obtains correct equation of perpendicular bisector ISW ACF	1.1b	A1	
	Subtotal		**5**	

Q	Marking instructions	AO	Marks	Typical solution
7(b)	Uses x-intercept of their equation to find their centre of the circle Or Forms two equations of the form $(x - a)^2 + y^2 = r^2$	3.1a	M1	When $y = 0$, $x = -3$ (–3, 0) to (4, 1) = $\sqrt{7^2 + 1^2}$ radius = $\sqrt{50}$ $(x + 3)^2 + y^2 = 50$
	Uses the distance formula between two points at least one of which must be A(4 , 1) or B(−8 , 5) Or Solves their two equations to find their a and uses this a to find their r	1.1a	M1	
	Obtains r = $\sqrt{50}$ or $r^2 = 50$ PI by correct answer	1.1b	A1	
	Obtains $(x + 3)^2 + y^2 = 50$ OE	1.1b	A1	
	Subtotal		**4**	

	Question 7 Total		**9**	

Q	Marking instructions	AO	Marks	Typical solution
8	Rewrites $\frac{18}{x}$ as $18x^{-1}$ PI by correct differentiation.	1.2	B1	$y = x^3 + 15x - 18x^{-1}$
	Differentiates, at least one term correct ACF	3.1a	M1	$\frac{dy}{dx} = 3x^2 + 15 + \frac{18}{x^2}$
	Obtains $\frac{dy}{dx} = 3x^2 + 15 + \frac{18}{x^2}$	1.1b	A1	For stationary point $3x^2 + 15 + \frac{18}{x^2} = 0$ $3x^4 + 15x^2 + 18 = 0$ $x^4 + 5x^2 + 6 = 0$ $(x^2 + 2)(x^2 + 3) = 0$ $x^2 = -2$ or $x^2 = -3$ No real solutions for x No stationary points
	Equates their derivative to 0 and solves for x^2 or x Or Uses $x^2 > 0$	1.1a	B1F	
	Deduces from correct working that there are no stationary points **with** a reason such as: Cannot square root negative values (of x) OE Or solutions for x are imaginary/not real Or shows that quartic > 0 Or shows that $\frac{dy}{dx} > 0$ Do not accept cannot be solved/cannot factorise Can score B1 M1 A1 B0 E1	2.2a	E1	
	Question 8 Total		**5**	

Q	Marking instructions	AO	Marks	Typical solution
9(a)	Substitutes the coordinates (1, 2) and (9, 2) to generate two equations. Allow one slip.	1.1a	M1	$2 = 1 - a + b$ $1 = -a + b$ $2 = 9 - 3a + b$ $-7 = -3a + b$ $a = 4$ $b = 5$
	Obtains two correct equations ACF	1.1b	A1	
	Obtains convincingly $a = 4$ and $b = 5$ If $a = 4$ is assumed to obtain $b = 5$ scores M1 A0 R0	1.1b	R1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
9(b)	Integrates $x - 4\sqrt{x} + 5$, at least one term correct, using their b value Condone non-substitution of a	3.1a	M1	Area under curve $= \int_1^9 (x - 4\sqrt{x} + 5)\,dx$ $\left[\frac{1}{2}x^2 - \frac{8}{3}x^{\frac{3}{2}} + 5x\right]_1^9$ $\frac{27}{2} - \frac{17}{6} = \frac{32}{3}$ Area of rectangle is $2 \times 8 = 16$ Shaded area is $16 - \frac{32}{3} = \frac{16}{3}$
	Obtains $\frac{1}{2}x^2 - \frac{8}{3}x^{\frac{3}{2}} + 5x$ FT their b value	1.1b	A1F	
	Substitutes correct limits into their integrated expression, including subtraction	1.1a	M1	
	Obtains area of $\frac{32}{3}$ OE including 10.6 recurring	1.1b	A1	
	Finds their integrated area −16 Or 16 − their integrated area Allow area obtained from calculator Provided 0 < their integrated area < 16	1.1a	M1	
	Completes reasoned argument to obtain correct area of $\frac{16}{3}$ AG	2.1	R1	
	Subtotal		**6**	

	Question 9 Total		**9**	

Q	Marking instructions	AO	Marks	Typical solution
10(a)(i)	Takes logarithms of both sides PI	1.1a	M1	$F = ae^{kt}$ $\ln F = \ln ae^{kt}$ $\ln F = \ln a + \ln e^{kt}$ $\ln F = \ln a + kt$
	Derives the required equation Must see either: $\ln F = \ln a + \ln e^{kt}$ Or $\ln F = \ln a + kt\ln e$	2.1	R1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
10(a)(ii)	Equates $\ln a$ to intercept value $6.55 \leq \ln a \leq 6.65$ Or Uses one/two points on graph to form 1/2 equations in $\ln a$ and k	3.1b	M1	$\ln a = 6.6$ $a = 735$ gradient = $0.5 = k$
	Equates k to a gradient value Or Solves equation(s) or uses F to find a value of a and/or a value of k	1.1a	M1	
	Obtains a value for a AWFW 700 to 773	1.1b	A1	
	Obtains a value for k AWFW 0.45 to 0.55	1.1b	A1	
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
10(b)(i)	Recalls rate of change of e^{kt} is ke^{kt} Condone done numerically using their a and k	1.2	M1	$\frac{dF}{dt} = kae^{kt} = kF$
	Obtains given result in algebraic terms only AG	2.1	R1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
10(b)(ii)	Substitutes their value for k provided $0.45 \leq k \leq 0.55$ and $F = 9200$ into the differential	3.4	M1	At $t = 5$ $\frac{dF}{dt} = 0.5 \times 9200$ $= 4600$ per day
	Obtains value for $\frac{dF}{dt}$ AWFW 4140 to 5060	3.2a	A1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
10(c)	Makes a suitable comment in context to explain why the number of followers will not be/unlikely to be more than 1 billion. E.g. Realistically the number of followers is too large. In reality, the number of followers will not continue to grow exponentially Singer may do something which causes followers to unfollow or lose followers Song may become less popular Song may not be to that number of people's taste New songs may be released No individual has a social media following of over 1 billion people Model only based upon days 2 and 5 so too much extrapolation People are fickle/lose interest If any incorrect statement is included with a correct statement(s) then E0	3.5a	E1	It is unlikely that the singer will have over one billion followers as that is too high a number. So, the exponential model will not to be valid after 30 days.
	Subtotal		**1**	

	Question 10 Total		**11**	

Q	Marking instructions	AO	Marks	Typical solution
11	Circles second answer	2.2a	B1	B
	Question 11 Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
12	Circles first answer	1.2	B1	Median
	Question 12 Total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
13(a)	Uses at least one correct ratio PI by at least one correct value	3.1a	M1	Year 10: $\frac{200}{720} \times 50 = 13.9$ Year 11: $\frac{240}{720} \times 50 = 16.7$ Year 12: $\frac{150}{720} \times 50 = 10.4$ Year 13: $\frac{130}{720} \times 50 = 9.0$ Y10: 14 Y11: 17 Y12: 10 Y13: 9
	Obtains at least 2 correct values Condone values given as decimals	1.1b	A1	
	Obtains all 4 correct integer values Y10: 14 Y11: 17 Y12: 10 Y13: 9 CAO	3.2a	A1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
13(b)	Gives any correct advantage of a stratified sample Accept: Provides greater precision/reliability The sample is representative of the population/each (year) group Unbiased	2.4	E1	Ensures each year group is included in the sample
	Subtotal		**1**	

	Question 13 Total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
14(a)	State one correct expression for the mean of X or the variance of Y using given values of n and p PI	1.1b	B1	Mean of $X = 40p$ Variance of $Y = 25 \times 0.6 \times 0.4$ $= 6$ So $40p = 6$ $p = \frac{3}{20}$
	Equates their mean and variance and solves to find a value for their p provided $0 < p < 1$ Do not accept mean of Y (15 giving $p = \frac{3}{8}$) as their variance of Y	3.1a	M1	
	Obtains $p = \frac{3}{20}$ ACF	1.1b	A1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
14(b)	Obtains correct probability AWRT 0.12	1.1b	B1	P($Y = 17$) = 0.1199797 = 0.120
	Subtotal		**1**	

	Question 14 Total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
15(a)	Sums probabilities and equates to one PI	1.1a	M1	$0.03+0.15+0.22+0.31+0.09+p = 1$
	Obtains $p = 0.2$	1.1b	A1	$p = 1 - (0.03+0.15+0.22+0.31+0.09)$ $= 0.20$
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
15(b)	Obtains at least one numerically correct term ACF	3.1b	M1	P(total is 3) = P(2 ∩ 1) + P(1 ∩ 2) + P(0 ∩ 3) + P(3 ∩ 0) = 0.22×0.15 + 0.15×0.22 + 0.03×0.31 + 0.31×0.03 = 2(0.033) + 2(0.0093) = 0.0846
	Obtains a correct numerically different second term which is added to the first term	3.1b	M1	
	Obtains 0.0846 OE	1.1b	A1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
15(c)(i)	Identifies independence or defines independence in context Or Identifies that the plants must be representative of the population. Do not accept assumption probabilities staying the same	3.2b	E1	The number of flowers that grow on one plant must be independent of the number that grow on any other plant
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
15(c)(ii)	Allow argument both ways with a valid contextualised reason from their assumption of independence from (c)(i) E.g. Could be independent as the plants are chosen randomly from a large batch, not dependent on each other for production of flowers Dependent because grown in the same soil, compete for resources, same batch of seeds. Or As plants are from a large batch, they are likely to be representative of the population	2.2b	E1	The plants may be grown in identical conditions and therefore the number of flowers that grow on each plant may not be independent.
	Subtotal		**1**	

	Question 15 Total		**7**	

Q	Marking instructions	AO	Marks	Typical solution
16(a)(i)	Obtains correct mean AWFW [0.053, 0.054]	1.1b	B1	Mean = $\frac{128.657}{2405}$ = 0.053496
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
16(a)(ii)	Obtains a value of the standard deviation in the range [0.0265, 0.0285]	1.1b	B1	Sd = $\sqrt{\frac{8.701707}{2405} - \left(\frac{128.657}{2405}\right)^2}$ = $\sqrt{0.00075639}$ = 0.0275
	Obtains value of the standard deviation AWRT 0.0275	1.1b	B1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
16(b)(i)	States that the claim is/may be incorrect. **With** a valid reason Eg Not every make of car is included in the LDS LDS does not reflect number of electric, gas/petrol in UK database Not every region is included in the LDS LDS only comes from 2 years LDS is a small sample compared to the entire UK database	2.2b	E1	The LDS does not include cars from every region of the UK, so the claim may be incorrect.
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
16(b)(ii)	States CO_2, CO or NOX	1.2	B1	CO_2
	Subtotal		**1**	

	Question 16 Total		**5**	

Q	Marking instructions	AO	Marks	Typical solution
17	States both hypotheses using correct notation. If a letter other than p is used, it must be correctly defined Accept 8% for 0.08	2.5	B1	
	States model used PI by P($X \geq 7$) = 0.10 P($X \geq 8$) = 0.04 P($X \leq 6$) = 0.90 P($X \leq 7$) = 0.96 AWRT Condone incorrect inequalities Condone P($X = 7$) = 0.06 P($X = 8$) = 0.03 AWRT as evidence of use	1.1a	M1	X is 'Number of vegan customers at the café' H_0: $p = 0.08$ H_1: $p > 0.08$ Under H_0: $X \sim B(50, 0.08)$
	Obtains 0.10 AWRT Condone 0.04 for A1 AWRT Or Critical region reject H_0 if $X \geq 8$ OE	1.1b	A1	P($X \geq 7$) = 1 – P($X \leq 6$) = 1 – 0.898128… = 0.102 As 0.102 > 0.05
	Compares 0.102 AWRT to 0.05 and states H_0 is not rejected. Or Compares 7 with critical region and states H_0 is not rejected. Condone accept H_0 and Reject H_1 Must see clear comparison	2.2b	A1	Do not reject H_0 There is insufficient evidence to suggest that the proportion of vegan customers at the café is greater than 8%.
	Concludes, from a fully correct comparison, in context, by referring to the proportion of vegan customers being greater than 8% OE Only award if B1 M1 A1 A1 Must not be too definite e.g. Use of 'insufficient', 'not significant', 'not enough'	3.2a	R1	
	Question 17 Total		**5**	

	Question Paper Total		**80**	