AQA

AS
FURTHER MATHEMATICS
7366/2S

Paper 2 Statistics

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.

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)

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 correct answer	1.1b	B1	0.1
	Question total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
2	Circles correct answer	1.1b	B1	28
	Question total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
3(a)	Obtains correct value of the median of A	1.1b	B1	Median = 1
	Sub total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
3(b)	Uses correct formula for $\mathrm{E}(A)$ or $\mathrm{E}(A^2)$	1.1a	M1	$\mathrm{E}(A) = 0\times0.45+1\times0.25$ $+2\times0.3$
	Obtains correct value of $\mathrm{E}(A)$ or $\mathrm{E}(A^2)$ **oe PI** by correct variance or standard deviation	1.1b	A1	$\mathrm{E}(A) = 0.85$ $\mathrm{E}(A^2) = 0^2\times0.45+1^2\times0.25$ $+2^2\times0.3$
	Uses correct formula for Var(A) or standard deviation of A with their values for $\mathrm{E}(A)$ and $\mathrm{E}(A^2)$	1.1a	M1	$\mathrm{E}(A^2) = 1.45$ $\mathrm{Var}(A) = 1.45-0.85^2$ $\mathrm{Var}(A) = 0.7275$
	Obtains correct standard deviation of A **AWRT** 0.853	1.1b	A1	Standard deviation = $\sqrt{0.7275}$ Standard deviation = 0.853
	Sub total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
3(c)	Uses correct formula for $\mathrm{Var}(9A-2)$ with their variance Condone substitution of their standard deviation for Var (A) provided formula stated	1.1a	M1	$\mathrm{Var}(9A-2) = 9^2\,\mathrm{Var}(A)$ $\mathrm{Var}(9A-2) = 9^2\times0.7275$ $\mathrm{Var}(9A-2) = 58.9275$
	Obtains correct value of Var($9A-2$) **AWRT** 58.9 **oe** **FT** their variance or their standard deviation squared multiplied by 81 from **3(b)** given to at least three significant figures	1.1b	A1F	$\mathrm{Var}(9A-2) = 58.9$ to 3 s.f.
	Sub total		**2**	

	Question total		**7**	

Q	Marking instructions	AO	Marks	Typical solution
4(a)	Obtains correct z value **AWRT** 2.58 **PI**	1.1b	B1	$z = 2.5758$ $\frac{5.429 - 5.239}{2} = 2.5758 \times \sqrt{\frac{0.7}{n}}$ $\sqrt{n} = 2.5758 \times \frac{\sqrt{0.7}}{\left(\frac{5.429 - 5.239}{2}\right)}$ $n = 515$
	Forms an equation containing their $2.5758 \times \sqrt{\frac{0.7}{n}}$ **PI**	3.1b	M1	
	Finds the correct value of n Whole number from 510 to 520 inclusive	3.2a	A1	
	Sub total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
4(b)	Infers that the confidence interval supports Joey's claim as 5.3 lies within the interval Condone use of "it" for 5.3 Condone "between the values" for being within the interval	2.2b	E1	The confidence interval supports the claim as 5.3 is within the interval
	Sub total		**1**	

	Question total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
5(a)	Uses at least one of $\int x^3 \, \mathrm{d}x$ or $\frac{9}{1696}\int x^3(x^2+1) \, \mathrm{d}x$ Condone missing $\mathrm{d}x$ **PI**	1.1a	M1	$\mathrm{P}(X<1.8)$ $=\int_0^1 x^3 \, \mathrm{d}x+\frac{9}{1696}\int_1^{1.8} x^3(x^2+1) \, \mathrm{d}x$ $=\frac{1}{4}+0.042$ $=0.292$
	Forms both correct integrals with correct limits with no other integrals $\int_0^1 x^3 \, \mathrm{d}x$ and $\frac{9}{1696}\int_1^{1.8} x^3(x^2+1) \, \mathrm{d}x$ **PI** or forms $\frac{9}{1696}\int_{1.8}^{3} x^3(x^2+1) \, \mathrm{d}x$ **OE** with no other integrals Condone missing $\mathrm{d}x$	1.1b	A1	
	Obtains correct value of $\mathrm{P}(X<1.8)$ **AWRT** 0.292	1.1b	A1	
	Sub total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
5(b)	Obtains the correct value of the lower quartile	1.1b	B1	Lower quartile = 1
	Sub total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
5(c)	Uses at least one of the correct integrals for the calculation of the form $\int \frac{f(x)}{x^2}\,dx$ with any limits Condone missing dx	1.1a	M1	$E\left(\frac{1}{X^2}\right) = \int_0^1 \frac{x^3}{x^2}\,dx + \int_1^3 \frac{9x^3(x^2+1)}{1696x^2}\,dx$ $= \int_0^1 x\,dx + \frac{9}{1696}\int_1^3 x^3 + x\,dx$ $= \frac{1}{2} + \frac{27}{212}$ $= \frac{133}{212}$
	Obtains the correct value for one of the integrals **OE**	1.1b	A1	
	Obtains the correct value for both of the integrals **OE**	1.1b	A1	
	Shows that $E\left(\frac{1}{X^2}\right) = \frac{133}{212}$ by first showing that $\int_0^1 \frac{x^3}{x^2}\,dx = \frac{1}{2}$ **OE** and $\int_1^3 \frac{9x^3(x^2+1)}{1696x^2}\,dx = \frac{27}{212}$ **OE** and adding them together Condone missing dx	2.1	R1	
	Sub total		**4**	

Q	Marking instructions	AO	Marks	Typical solution
5(d)	Obtains the correct value of $E(Y)$ May be unsimplified	1.1b	B1	$E(Y) = 3$
	Uses the formula $E\left(\frac{1}{X^2}+Y\right) = E\left(\frac{1}{X^2}\right) + E(Y)$ to obtain $\frac{133}{212}$ + their $E(Y)$	1.1a	M1	$E\left(\frac{1}{X^2}+Y\right) = E\left(\frac{1}{X^2}\right) + E(Y)$ $E\left(\frac{1}{X^2}+Y\right) = \frac{133}{212} + 3$
	Obtains the correct exact value of $E\left(\frac{1}{X^2}+Y\right)$	1.1b	A1	$E\left(\frac{1}{X^2}+Y\right) = \frac{769}{212}$
	Sub total		**3**	

	Question total		**11**	

Q	Marking instructions	AO	Marks	Typical solution
6(a)	Obtains the correct value of the variance	1.1b	B1	Variance = 42
	Sub total		**1**	

Q	Marking instructions	AO	Marks	Typical solution
6(b)	States both hypotheses using correct language	2.5	B1	$H_0 : \lambda = 42$ $H_1 : \lambda > 42$
	Uses Poisson model with $\lambda = 42$ to calculate any Poisson probability	3.3	M1	$Y \sim \text{Po}(42)$
	Uses Poisson model to calculate $P(Y \geq 53)$ **AWRT** 0.057	3.4	A1	$P(Y \geq 53) = 0.057$ $0.057 > 0.05$ Accept H_0
	Evaluates the Poisson model by correctly comparing their probability with 0.05	3.5a	R1	Insufficient evidence to suggest that the mean number of computers sold per day has increased
	Infers H_0 not rejected **FT** 'their comparison using a Poisson model'	2.2b	E1F	
	Concludes in context. Must refer to the mean number of computers. (Conclusion must not be definite) **FT** 'their' incorrect rejection of H_0 if stated or 'their' comparison if not	3.2a	E1F	
	Sub total		**6**	

Q	Marking instructions	AO	Marks	Typical solution
6(c)	States the meaning in context of a Type II error Condone missing "mean" or "per day" Condone "changed" for "increased"	3.2a	E1	Type II error is to conclude that the mean number of computers sold per day has not increased when it has
	Sub total		**1**	

	Question total		**8**	

Q	Marking instructions	AO	Marks	Typical solution
7(a)	States that there is an expected frequency less than 5	1.1b	B1	There is an expected frequency less than 5
	Explains how to refine model so that the degrees of freedom for the test is 4 If specific rows are mentioned, must include North	2.4	E1	This means either: Two rows have to be merged so that the degrees of freedom for the test is 4
	Explains how to refine model so that the degrees of freedom for the test is 3 If specific columns are mentioned, must include C	2.4	E1	Or two columns have to be merged so that the degrees of freedom for the test is 3
	Sub total		**3**	

Q	Marking instructions	AO	Marks	Typical solution
7(b)	States both hypotheses using correct language **OE** Variables need to be stated in at least the null hypothesis	2.5	B1	H_0: There is no association between region and washing powder H_1: There is an association between region and washing powder
	Obtains correct critical value for the test **AWRT** 13.3 or corresponding probability of test statistic **AWRT** 0.009	1.1b	B1	χ^2 cv for 4 dof = 13.277 $13.6 > 13.277$
	Evaluates χ^2 – test statistic by correctly comparing their critical value with the test statistic or the probability with 0.01	3.5a	R1	Reject H_0
	Infers H_0 rejected **FT** 'their comparison using a χ^2 model'	2.2b	E1F	Some evidence to suggest that there is an association between region and brand of washing powder used
	Concludes in context (Conclusion must not be definite) **FT** 'their' incorrect acceptance of H_0 if stated or 'their' comparison if not	3.2a	E1F	
	Sub total		**5**	

	Question total		**8**	

	Paper total		**40**	