GCE A level Mathematics (9AM0) – Paper 31
Statistics

October 2020 student-friendly mark scheme

Please note that this mark scheme is not the one used by examiners for making scripts. It is intended more as a guide to good practice, indicating where marks are given for correct answers. As such, it doesn't show follow-through marks (marks that are awarded despite errors being made) or special cases.

It should also be noted that for many questions, there may be alternative methods of finding correct solutions that are not shown here – they will be covered in the formal mark scheme.

This document is intended for guidance only and may differ significantly from the final mark scheme published in December 2020.

Guidance on the use of codes within this document
M1 – method mark. This mark is generally given for an appropriate method in the context of the question. This mark is given for showing your working and may be awarded even if working is incorrect. A1 – accuracy mark. This mark is generally given for a correct answer following correct working. B1 – working mark. This mark is usually given when working and the answer cannot easily be separated. Some questions require all working to be shown; in such questions, no marks will be given for an answer with no working (even if it is a correct answer).

Question 1 (Total 8 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	A and C **or** D and B **or** D and C	B1 1.2	This mark is given for one correct pair stated (if more than one pair is stated, they must be correct)
(b)	$p = 0.4 - 0.07 - 0.24 = 0.09$	B1 1.1b	This mark is given for the correct answer only
(c)	$P(A) \times 0.4 = 0.24$ $P(A) = 0.6$	M1 1.1b	This mark is given for a correct equation for $P(A)$
	$q = 0.20$	A1 1.1b	This mark is given for the correct answer only
(d)(i)	$P(B' \mid C) = 0.64 \Rightarrow \frac{r}{r+p} = 0.64$ $r = 0.64r + 0.64p$ $0.36r = 0.0576$	M1 3.1a	This mark is given for the use of $P(B' \mid C) = 0.64$ leading to a correct formula in terms of r and p
	$r = 0.16$	A1 1.1b	This mark is given for the correct answer only
(d)(ii)	$0.6 + 0.07 + 0.25 + s = 1$	M1 1.1b	This mark is given for using the total probability = 1 to form a linear equation for s
	$s = 0.08$	A1 1.1b	This mark is given for the correct answer only

Question 2 (Total 7 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	Negative	B1 1.2	This mark is given for the correct answer only
(b)	Rainfall	B1 2.2b	This mark is given for the correct answer only
	mm	B1 1.1b	This mark is given for the correct answer only
(c)	H_0: $\rho = 0$, H_1: $\rho \neq 0$	B1 2.5	This mark is given for two correct hypotheses in terms of ρ
	Critical value: – 0.3610	M1 1.1b	This mark is given for a correct critical value found
	$r < -0.3610$ a significant result; thus there is evidence of a correlation between the Daily Total Sunshine and the Daily Maximum Relative Humidity	A1 2.2b	This mark is given for a correct conclusion given in context
	Humidity is high and there is evidence of correlation and $r < 0$ Thus we would expect the amount of sunshine to be lower than the average for Heathrow	B1 2.2b	This mark is given for a conclusion for stating referring to high humidity, $r < 0$ and a low amount of sunshine

Question 3 (Total 10 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	68 – 7 = 61	B1 1.1b	This mark is given for the correct answer only
(b)	25 – 14 = 11	B1 1.1b	This mark is given for the correct answer only
(c)	$\bar{x} = \frac{607.5}{27} = 22.5$	B1 1.1b	This mark is given for the correct answer only
(d)	$\sigma = \sqrt{\frac{17623.25}{27} - 22.5^2}$	M1 1.1b	This mark is given for a method to calculate the standard deviation
	= 12.1	A1 1.1b	This mark is given for the correct answer only (to 1 decimal place)
(e)	$\mu + 3\sigma = 22.5 + (3 \times 12.1) = 58.8$ Only one outlier	B1 1.1b	This mark is given for the correct answer and reason given
(f)	The median time increases means that both values must be > 20	M1 3.1b	This mark is given for a correct statement about the values based on the median
	The mean time does not change is the same means that $a + b = 45$	M1 1.1b	This mark is given for for a correct explanation leading to an equation for $a + b$
	For example: Possible values are $b = 21$ and $a = 24$	A1 2.2b	This mark is given for a correct pair of values (a and b both > 20 and adding to 45) stated
(g)	Both values will be less than 1 standard deviation from the mean, so the standard deviation of all 29 values will be smaller	B1 2.4	This mark is given for a correct explanation

Question 4 (Total 10 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$\frac{k}{10} + \frac{k}{20} + \frac{k}{30} + \frac{k}{40} + \frac{k}{50} = 1$ $\frac{1}{600}(60k + 30k + 20k + 15k + 12k) = 1$	M1 1.1b	This mark is given for a method to find the value of k
	$k = \frac{600}{137}$	A1 1.1b	The mark is given for fully correct working leading to the given answer
(b)	$D_1 = 30, D_2 = 50$ or $D_1 = 50, D_2 = 30$ or $D_1 = 40, D_2 = 40$	M1 2.1	This mark is given for a method to select all the relevant cases
	$\text{P}(D_1 + D_2 = 80) = \frac{k}{50} \times \frac{k}{30} \times 2 + \left(\frac{k}{40}\right)^2$	M1 3.4	This mark is given for a method to use the model to obtain a correct expression for the probability
	$= 0.0376$	A1 1.1b	This mark is given for the correct answer only
(c)	Angles are a, $a + d$, $a + 2d$, $a + 3d$	M1 3.1a	This mark is given for a method to find expressions for the four angles in terms of a and d
	$S_4 = 2(2a + 3d) = 360$	M1 2.1	This mark is given for using the properties of a quadrilateral with the four angles
	$2a + 3d = 180$	A1 2.2a	This mark is given for finding $2a + 3d = 180$
	Smallest angle is $a > 50$ $d = 10$ so $a = 75$ or $d = 20$ so $a = 60$	M1 3.1b	This mark is given for a method to examine the possible cases and using $d = 10$ and $d = 20$ only
	$\text{P}(d = 10 \text{ or } 20) = \frac{k}{10} + \frac{k}{20} = \frac{3k}{20} = \frac{90}{137}$	A1 1.1b	This mark is given for a correct answer only

Question 5 (Total 15 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$P(x > 15) = 0.106$	B1 1.1b	This mark is given for the correct answer only
(b)	$H_0: \mu = 10, \quad H_1: \mu > 10$	B1 2.5	This mark is given for two correct hypotheses in terms of μ
	$\overline{X} \sim N\left(10, \left(\frac{4}{\sqrt{20}}\right)^2\right)$	M1 3.3	This mark is given for a selection of a correct model
	$P(\overline{X} > 11.5) = 0.046766$	A1 3.4	This mark is given for using this model to find the probability
	This is significant (< 5%) so there is evidence to support the complaint	A1 2.2b	This mark is given for a correct conclusion in context
(c)(i)	$P(T < 2) = 0.196$	B1 1.1b	This mark is given for the correct answer only
(c)(ii)	$\frac{P(0 < T < 2)}{P(T > 0)} = \frac{0.119119}{0.923436}$	M1 3.4	This mark is given for a method to form a probability ratio expression
		A1 1.1b	This mark is given for a correct ratio of probabilities
	= 0.1289955	A1 1.1b	This mark is given for a correct answer only
(c)(iii)	The current model suggests a nonnegligible probability of T values < 0, which is impossible	B1 3.5b	This mark is given for a suitable explanation of why model is not suitable based on negative T values
(d)	See over		

Question 5 (Total 15 marks) continued

Part	Working or answer an examiner might expect to see	Mark	Notes
(d)	$P(T > t \mid T > 2) = 0.5$	M1 3.1b	This mark is given for a correct conditional probability statement to start the problem
	$\frac{P(T > t)}{P(T > 2)} = 0.5$	M1 1.1b	This mark is given for a correct ratio of probability expressions
	$P(T > t) = 0.5 \times (1 - 0.196)$	A1 3.4	This mark is given for a correct equation for $P(T > t)$
	$P(T > t) = 0.402 \Rightarrow \frac{t - 5}{3.5} = 0.2533$ or $P(t < t) = 0.5978$	M1 1.1b	This mark is given for a method to find t
	$t = 5.9$ (to 1 decimal place)	A1 1.1b	This mark is given for a correct answer only