

DRAFT GCE A level Mathematics (9MA0) – Paper 31 Statistics

Summer 2019 Shadow Paper 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 mark schemes used by examiners.

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)		B1	This mark is given for a correct shape and labels for a tree diagram
		B1	This mark is given for the correct probabilities shown
(b)	$\frac{7}{8} \times \frac{7}{8} \times \frac{9}{10}$	M1	This mark is given for a multiplication of three probabilities
	$= \frac{441}{640}$	A1	This mark is given for the correct probability that Julia selects three scarves
(c)	$\left(\frac{7}{8} \times \frac{1}{8}\right) + \left(\frac{7}{8} \times \frac{7}{8} \times \frac{1}{10}\right)$	M1	This mark is given for the addition of two products
	$= \frac{119}{640}$	A1	This mark is given for the correct probability that Julia selects at least one scarf of each colour
(d)	$P(\text{red from } B \mid \text{red selected}) =$ $\frac{\frac{7}{8} \times \frac{1}{8}}{1 - \frac{441}{640}} = \frac{7}{64} \times \frac{640}{199}$	M1	This mark is given for determining the correct ratio of probabilities
	$= \frac{70}{199}$	A1	This mark is given for the correct probability that Julia selects a red scarf from bag B

Question 2 (Total 11 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$IQR = 26.6 - 19.4 = 7.2$	B1	This mark is given for finding the interquartile range
	$19.4 - (1.5 \times 7.2) = 8.6$ $26.6 + (1.5 \times 7.2) = 37.4$	M1	This mark is given for a method find the values for the whiskers of the boxplot
	Plotting 7.6°C as an outlier. With whiskers plotted at 31.6 °C as the upper and 8.6 °C (or 9.5°C) as the lower	A1	This mark is given for plotting the correct outlier 7.6 °C
		A1	This mark for plotting both whiskers correct
(b)	October (since it is the month with the coldest temperatures between May and October in Beijing)	B1	This mark is given for a correct suggestion with a supporting reason.
(c)	$\sigma = \sqrt{\frac{S_{xx}}{n}} = \sqrt{\frac{4877.585}{166}} = \sqrt{29.38} = 5.42$	B1	This mark is given for showing the calculation for the standard deviation to three significant figures
(d)	$z = (\pm) 1.2816$	B1	This mark is given for identifying the z-value for the 10th and 90th percentiles (from tables or calculator)
	$2 \times z \times 5.42$	M1	This mark is given for a method to find the interpercentile range between the 10th and 90th value
	$= 13.9$	A1	This mark is given for finding a correct interpercentile range between the 10th and 90th value
(e)	Daily wind speed (Beaufort) since it is qualitative data	B1	This mark is given for stating a correct variable with a supporting reason
	Rainfall (since it is not symmetric)	B1	This mark is given for stating a correct variable with a supporting reason

Question 3 (Total 9 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$H_0 : \rho = 0$ $H_1 : \rho > 0$	B1	This mark is given for both hypotheses in terms of ρ found correctly
	For sample size 24 at the 5% level of significance, the critical value = 0.3438	M1	This mark is given for selecting a suitable critical value compatible with H_1
	$0.4771 > 0.3438$, so reject H_0 There is evidence that the product moment correlation coefficient (pmcc) is greater than 0	A1	This mark is given for a correct conclusion stated
(b)	The value of the pmcc is close to 1 so there is a strong positive correlation	B1	This mark is given for a correct explanation about the strength of the correlation
(c)	$\log_{10} y = -0.47 + 0.92 \log_{10} x$	M1	This mark is given for a correct substitution of both c and m
	$y = 10^{-0.47 + 0.92 \log x}$	M1	This mark is given for dealing with logs to find an expression in terms of y
	$y = 10^{-0.47} \times 10^{0.92 \log x}$ $y = 10^{-0.47} \times 10^{(\log x)^{0.92}}$	M1	This mark is given for a method to find values for a and n
	$y = 0.34 \times x^{0.92}$	A1	This mark is given for find a correct value of $a = 0.34$
		A1	This mark is given for find a correct value of $n = 0.92$

Question 4 (Total 9 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$\frac{59+31}{195} = \frac{90}{195} = 0.462$	B1	This mark is given for a correct value for the probability for the cloud cover
(b)(i)	$P(X \geq 7) = 1 - P(X \leq 6)$	M1	This mark is given for using $1 - P(X \leq 5)$ with $B(8, 0.78)$
	$= 1 - 0.5538$ $= 0.446$	A1	This mark is given for finding as correct value for the probability
(b)(ii)	$195 \times P(X = 7)$ $= 195 \times 0.3092$	M1	This mark is given for using $195 \times P(X = 7)$ with $B(8, 0.78)$
	$= 60.3$	A1	This mark is given for finding a correct value for the expected number of days
(c)	The answer to part (b)(i) of 0.446 is similar to 0.462 in part (a) The answer to part (b)(ii) of 60.3 is very close to 59 found in the data set	B1	This mark is given for a correct evaluation of the outcomes from part (b) to determine the appropriateness of Chen's model
(d)	$\frac{9+11}{31} = \frac{20}{31} = 0.645$	B1	This mark is given for a correct value for the probability for the cloud cover
(e)	The answer to part (d) of 0.645 is greater than that in part (a) of 0.462 This shows that there is a higher chance of having high cloud cover if the previous day had high cloud cover	B1	This mark is given for a correct comparison for the answer to part (d) with the data set
	Thus independence does not hold so a binomial model might not be suitable	B1	This mark is given for a correct conclusion stated

Question 5 (Total 13 marks)

Part	Working or answer an examiner might expect to see	Mark	Notes
(a)	$\frac{27.29 - 28}{\sigma} = -1.6449$	M1	This mark is given for standardising as part of a method to find σ
	$\sigma = 0.4316$	A1	This mark is given for a correct value of σ
	$P(D > K) = 0.6$ or $P(D < K) = 0.4$	B1	This mark is given for finding two probabilities
	$\frac{k - 28}{\sigma} = \frac{k - 28}{0.4316} = 0.2533$	M1	This mark is given for using a normal model to find the probability
	$k = 28.11$	A1	This mark is given for a correct value for k
(b)	$Y \sim B(200, 0.55)$ so $W \sim N(110, 49.5)$	B1	This mark is given for setting up the normal distribution approximation of the binomial
	$P(Y < 100) \approx P(W < 99.5) = P\left(Z < \frac{99.5 - 110}{\sqrt{49.5}}\right)$	M1	This mark is given for using the normal model with a continuity correction
	$= 0.0678$	A1	This mark is given for finding a correct value of the probability
(c)	$H_0 : \mu = 28$ $H_1 : \mu < 28$	B1	This mark is given for both hypotheses in terms of μ found correctly
	$\bar{D} \sim N\left(28, \frac{0.7^2}{20}\right)$	M1	This mark is given for a method to set up the normal distribution
	$P(\bar{D} < 27.72) = 0.0368$	A1	This mark is given for using the model to find a correct p -value
	$p = 0.0368 < 0.05$, so reject H_0	M1	This mark is given for a correct comparison and non-contextual conclusion
	There is sufficient evidence to support Hannah's belief that the mean amount of liquid put in each bottle is less than 28 ml	A1	This mark is given for a correct conclusion in context stated