**GCE A level Mathematics (9MA0) – Paper 31**

**Statistics**

**Summer 2019 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 July 2019.**

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| **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)**

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| **Part** | **Working or answer an examiner might expect to see** | **Mark** | **Notes** |
| (a) | G  R  G  R  G  R  G    G  G  G  G | 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) | ×  × | M1 | This mark is given for a multiplication of three probabilities |
| = | A1 | This mark is given for the correct probability that Sasha selects three marbles |
| (c) | ×  +  × | M1 | This mark is given for the addition of two products |
| = | A1 | This mark is given for the correct probability that Sasha selects at least one marble of each colour |
| (d) | P(red form *B* ⎪ red selected) =  =  × | M1 | This mark is given for determining the correct ratio of probabilities |
| = | A1 | This mark is given for the correct probability that Sasha selects a red marble from bag *B* |

**Question 2 (Total 11 marks)**

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| **Part** | **Working or answer an examiner might expect to see** | **Mark** | **Notes** |
| (a) | IQR = 2.6. – 19.4 = 7.2 | B1 | This mark is given for finding the interquartile range |
| 19.4 – (1.5 × 7.2) = 8.6  19.4 + (1.5 × 7.2) = 37.4 | M1 | This mark is given for a method find the values for the whiskers of the boxplot |
|  | | |
|  | A1 | This mark is given for plotting the correct whisker (8.6) on the boxplot |
| A1 | This mark is given for plotting the two correct outliers 7.6 °C and 8.1 °C |
| (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) | *σ* =  =  = √26.92 = 5.19 | B1 | This mark is given for showing the calculation for the standard deviation to three significant figures |
| (d) | z= (±) 1.2816 | B1 | This mark is given for identifying the z‑value for the 10th and 90th percentiles (from tables or calculator) |
| 2 × *z* × 5.19 | M1 | This mark is given for a method to find the interpercentile range between the 10th and 90th value |
| = 13.303 | 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 si given for stating a correct variable with a supporting reason |
| Rainfall (since it is not symmetric) | B1 | This mark si given for stating a correct variable with a supporting reason |

**Question 3 (Total 9 marks)**

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| **Part** | **Working or answer an examiner might expect to see** | **Mark** | **Notes** |
| (a) | H0 : *ρ* = 0  H1 : *ρ* > 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 H1 |
| 0.446 > 0.3438, so reject H0  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) | log10 *y* = –1.82 + 0.89 log10 *x* | M1 | This mark is given for a correct substitution of both *c* and *m* |
| *y* = 10–1.82 + 0.89 log *x* | M1 | This mark is given for dealing with logs to find an expression in terms of *y* |
| *y* = 10–1.82 × 10 0.89 log *x*  *y* = 10–1.82 × | M1 | This mark is given for a method to find values for *a* and *n* |
| *y* = 0.015 × *x*0.89 | A1 | This mark is given for find a correct value of *a* = 0.015 |
| A1 | This mark is given for find a correct value of *n* = 0.89 |

**Question 4 (Total 9 marks)**

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| **Part** | **Working or answer an examiner might expect to see** | **Mark** | **Notes** |
| (a) | =  = 0.717 | B1 | This mark is given for a correct value for the probability for the cloud cover |
| (b)(i) | P(*X* ≥ 6) = 1 – P(*X* ≤ 5) | M1 | This mark is given for using 1 – P(*X* ≤ 5) with B(8, 0.76) |
| = 1 – 0.2967  = 0.703 | A1 | This mark is given for finding as correct value for the probability |
| (b)(ii) | 184 × P(*X* = 7)  = 184 × 0.2811 | M1 | This mark is given for using 184 × P(*X* = 7) with B(8, 0.76) |
| = 51.7 | A1 | This mark is given for finding as correct value for the probability |
| (c) | The answer to part (b)(i) of 0.703 is similar to 0.7127 in part (a)  The answer to part (b)(ii) of 51.7 is very close to 52 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 Magali’s model |
| (d) | =  = 0.821 | B1 | This mark is given for a correct value for the probability for the cloud cover |
| (e) | The answer to part (d) of 0.821 is greater than that in part (a) of 0.717  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)**

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| **Part** | **Working or answer an examiner might expect to see** | **Mark** | | **Notes** | |
| (a) | = –1.0364 | M1 | | This mark is given for standardising as part of a method to find *σ* | |
| *σ* = 0.357 | A1 | | This mark is given for a correct value of *σ* | |
| P(*D* > *K*) = 0.4 or P(*D* < *K*) = 0.6 | B1 | | This mark is given for | |
| =  = 0.2533 | M1 | | This mark is given for using a normal model to find the probability | |
| *k* = 25.09 | A1 | | This mark is given for a correct value for *k* | |
| (b) | *Y* ~ B(200, 0.45) so *W* ~ N(90, 49.5) | B1 | | This mark is given for setting up the normal distribution approximation of the binomial | |
| P(*Y* < 100) ≈ P(*W* < 99.5) = P | | M1 | | This mark is given for using the normal model with a continuity correction |
| = 0.912 | A1 | | This mark is given for finding a correct value of the probability | |
| (c) | H0 : *μ*  = 25  H1 : *μ*  < 25 | B1 | | This mark is given for both hypotheses in terms of *μ* found correctly | |
| ~ N | M1 | | This mark is given for a method to set up the normal distribution | |
| P( < 24.94) = 0.0468 | A1 | | This mark si govern for using the model to find a correct *p*-value | |
| *p* = 0.0468 < 0.05, so reject H0 | M1 | | This mark si given for a correct comparison and non-contextual conclusion | |
| There is sufficient evidence to support Hannah’s belief | A1 | | This mark is given for a correct conclusion in context stated | |