GCE A level Mathematics (9AM0) – Shadow Paper (Set 1)
9MA0-31 Statistics

October 2020 Shadow Paper 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, indicating where marks are given for correct answers. As such, it may not 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 from the original paper.

This document is intended for guidance only and may differ significantly from the examiners' final mark scheme for the original paper which was 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).

Qu 1	Scheme	Marks	AO
(a)	*P*, R or S, Q or S,R	B1 **(1)**	1.2
(b)	[$p = 0.5 - 0.09 - 0.36$ =] **0.05**	B1 **(1)**	1.1b
(c)	*A* and *B* independent implies $\mathrm{P}(P)\times 0.5 = 0.36$ or $(q + 0.2 + 0.36)\times 0.5 = 0.36$ so P(*P*) = 0.72 and *b* = **0.16**	M1 A1cso **(2)**	1.1b 1.1b
(d)(i)	$\mathrm{P}(Q' \mid R) = 0.6$ gives $\frac{c}{c+a} = 0.6$ or $\frac{c}{c+"0.05"} = 0.06$ $c = 0.6c + 0.6$ "a" so $0.6c = 0.03$ so c = **0.075**	M1 A1	3.1a 1.1b
(ii)	Using sum of probabilities = 1 e.g. "0.72" + 0.09 + "0.125" + d =1 so s = **0.065**	M1 A1 **(4)**	1.1b 1.1b
		(8 marks)	

Qu 2	Scheme	Marks	AO
(a)	Negative	B1 **(1)**	1.2
(b)(i)	Rainfall	B1	2.2b
(ii)	mm or Pressure hPa or Pascals or hectopascals or mb or millibars	B1ft **(2)**	1.1b
(c)	$\mathrm{H}_0 : \rho = 0$ $\mathrm{H}_1 : \rho \neq 0$	B1	2.5
	Critical value: – 0.396(1)	M1	1.1b
	$r >$ – 0.3961 so not a significant result; thus there is no evidence of a correlation between the Daily Total Sunshine and the Daily Maximum Relative Humidity	A1 **(3)**	2.2b
(d)	Humidity is high but there is no evidence of correlation. Thus we cannot expect the amount of sunshine will be lower than the average for Heathrow(oe)	B1 **(1)**	2.2b
		(7 marks)	

Qu 3	Scheme	Marks	AO
(a)	[408 – 42 =] **366** (only)	B1 **(1)**	1.1b
(b)	[150 – 84] = **66**	B1 **(1)**	1.1b
(c)	$\left[\mu \text{ or } \bar{x} = \frac{3850}{35} = \right]$ = **110**	B1 **(1)**	1.1b
(d)	$\sigma = \sqrt{\frac{575960}{35} - "110"^2}$ or $\sqrt{4356}$	M1	1.1b
	= **66**	A1 **(2)**	1.1b
(e)	$\mu + 3\sigma = "110" + 3 \times "66" = 308$ so only **one** outlier	B1ft **(1)**	1.1b
(f)	Median increases implies that both values must be > 120 Mean is the same means that $a + b = 220$ So possible values are: e.g. $b = 105$ and $a = 115$ (o.e.)	M1 M1 A1 **(3)**	3.1b 1.1b 2.2b
(g)	Both values will be less than 1 standard deviation from the mean and so the standard deviation of all 29 values will be smaller	B1 **(1)**	2.4
		(10 marks)	

Qu 4	Scheme	Marks	AO
(a)	$\frac{c}{5} + \frac{c}{10} + \frac{c}{15} + \frac{c}{20} + \frac{c}{25} = 1$ or $\frac{1}{300}(60c + 30c + 20c + 15c + 12c) = 1$	M1	1.1b
	So $k = \frac{300}{137}$ (*)	A1cso **(2)**	1.1b
(b)	(Cases are:) $D_1 = 25, D_2 = 15$ and $D_1 = 15, D_2 = 25$ and $D_1 = 20, D_2 = 20$	M1	2.1
	$\text{P}(D_1 + D_2 = 40) = \frac{c}{25} \times \frac{c}{15} \times 2 + \left(\frac{c}{20}\right)^2$	M1	3.4
	= 0.0376… awrt **0.0376**	A1 **(3)**	1.1b
(c)	Angles are: a, $a + d$, $a + 2d$, $a + 3d$	M1	3.1a
	$S_4 = a + (a + d) + (a + 2d) + (a + 3d) = 360$	M1	2.1
	$2a + 3d = 180$ (o.e.)	A1	2.2a
	Smallest angle is $a > 65$ consider cases: $d = 5$ so $a = 82.5$ or $d = 10$ so $a = 75$ or $d = 15$ gives $a = 67.5$	M1	3.1b
	$\text{P}(D = 5 \text{ or } 10 \text{ or } 15) = \frac{c}{5} + \frac{c}{10} + \frac{c}{15} = \frac{11c}{30} = \frac{110}{137}$	A1 **(5)**	1.1b
		(10 marks)	

Qu 5	Scheme	Marks	AO
(a)	{Let X = time spent, P(X > 40) = } 0.106… awrt **0.106**	B1 **(1)**	1.1b
(b)	$H_0 : \mu = 25$ $H_1 : \mu > 25$	B1	2.5
	$\bar{X} \sim N\left(25, \left(\frac{12}{\sqrt{30}}\right)^2\right)$; $P(\bar{X} > 28) = 0.08545\ldots$	M1;A1	3.3;3.4
	[This is not significant (> 5%) so] there is no evidence to support the complaint	A1 **(4)**	2.2b
(c)(i)	[P(T < 3) =] 0.3445… awrt **0.345**	B1 **(1)**	1.1b
(ii)	Require $\frac{P(0<T<3)}{P(T>0)} = \frac{0.289778...}{0.945200...}$; = 0.30657929… awrt **0.307**	M1 A1;A1 **(3)**	3.4 1.1bx2
(iii)	The current model suggests **non-negligible** probability of T values < 0 which is impossible	B1 **(1)**	3.5b
(d)	Require t such that P(T > t | T > 3) = 0.5 or P(T < t | T > 3) = 0.5	M1	3.1b
	e.g. $\frac{P(T>t)}{P(T>3)} = 0.5$; so P(T > t) = 0.5×[1 – (c)(i)] or P(T > t) = 0.5× 0.6555..	M1; A1ft	1.1b 3.4
	[i.e. P(T > t) = 0.3275… implies] $\frac{t-4}{2.5} = 0.44682...$ or P(T < t) = "0.6725..."	M1	1.1b
	t = 5.11705… so awrt **5.1**	A1 **(5)**	1.1b
		(15 marks)	