January 2019

Mark Scheme

Mock Paper (Set1)

Pearson Edexcel GCE A Level Mathematics

Statistics (9MA0/31)

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification/indicative content will not be exhaustive.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, a senior examiner must be consulted before a mark is awarded.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

PEARSON EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 100

2. These mark schemes use the following types of marks:

- **M** marks: Method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

   These are some of the traditional marking abbreviations that will appear in the mark schemes.

   - **bod** – benefit of doubt
   - **ft** – follow through
   - the symbol $\surd$ will be used for correct ft
   - **cao** – correct answer only
   - **cso** - correct solution only. There must be no errors in this part of the question to obtain this mark
   - **isw** – ignore subsequent working
   - **awrt** – answers which round to
   - **SC**: special case
   - **o.e.** – or equivalent (and appropriate)
   - **d** or **dep** – dependent
   - **indep** – independent
   - **dp** decimal places
   - **sf** significant figures
   - ***** The answer is printed on the paper or ag- answer given

4. All M marks are follow through.

   A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but answers that don't logically make sense e.g. if an answer given for a probability is >1 or <0, should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. Where a candidate has made multiple responses and indicates which response they wish to submit, examiners should mark this response.
   If there are several attempts at a question which have not been crossed out, examiners should mark the final answer which is the answer that is the most complete.

7. Ignore wrong working or incorrect statements following a correct answer.

8. Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternatives answers are provided in the notes. If examiners are not sure if an answer is acceptable, they will check the mark scheme to see if an alternative answer is given for the method used. If no such alternative answer is provided but the response is deemed to be valid, examiners must escalate the response for a senior examiner to review.

Question	Scheme	Marks	AOs
1(a)	$[\bar{x} =] \frac{798}{30} = 26.6$	B1 cao	1.1b
	$[\sigma_x =] \sqrt{\frac{21357.5}{30} - \bar{x}^2} = \sqrt{4.35666\ldots} = \text{awrt} 2.09$ Allow $[s =] \sqrt{\frac{21357.5 - 30\bar{x}^2}{29}} = \text{awrt} 2.12$	B1	1.1b
		(2)	
(b)	$[\bar{x} - 3\sigma =] 14.8 - 3 \times 2.37 = 7.69$ or $[\bar{x} + 3\sigma =] 14.8 + 3 \times 2.37 = 21.91$	M1	2.1
	$8.8 > 7.69$ and $18.5 < 21.91$ so no outliers	A1	1.1b
		(2)	
(c)(i)	Mean for Perth is lower than mean for Jacksonville which suggests the daily mean air temperature is higher in the northern hemisphere (in June).	B1	2.2b
	Standard deviations are similar which suggests similar levels of variation of the daily mean air temperature in each hemisphere (in June). OR Sizes of standard deviations are small compared with the difference in mean temperatures making it more likely that the difference in means is significant.	B1	2.2b
		(2)	
(ii)	This is based on one location in each hemisphere and therefore is not valid as temperatures are likely to vary across each hemisphere.	B1 (1)	2.4
(d)	$\mathrm{P}(X > 29) = 0.17045\ldots$	M1	3.4
	5.11 days (accept awrt 5)	A1	1.1b
		(2)	
			(9 marks)

Question 1 continued

Notes:

(a)
B1: for mean
B1: awrt 2.09 (allow $s = 2.12$)

(b)
M1: for a correct method to find the lower or upper limit for outliers
A1: for comparing minimum and maximum values to outlier limits and concluding

(c) (i)
B1: for a suitable comparison of means and comment in context
B1: for a suitable comparison of standard deviations and comment in context
Do not accept e.g "Standard deviation for Perth is higher than standard deviation for Jacksonville which suggests daily mean air temperature is more consistent in the northern hemisphere (in June)" because students should be familiar with the idea that small differences in these statistics are not always meaningful and should be aware of the likely size of differences having explored the large data set.
(ii)
B1: a suitable explanation why assumption is not valid.

(d)
M1: for use of the model to attempt a correct probability
A1: for a correct prediction

Question	Scheme	Marks	AOs
2(a)(i)	Extrapolation is making predictions outside the original data range.	B1	1.2
(a)(ii)	This is unreliable as the trend may not continue.	B1	2.4
		(2)	
(b)	The product moment correlation coefficient cannot be greater than 1	B1	1.2
		(1)	
(c)	$r = 0.76279\ldots$ awrt 0.763	B1	1.1b
		(1)	
(d)	$\mathrm{H}_0\colon \rho = 0 \qquad \mathrm{H}_1\colon \rho > 0$	B1	2.5
	Critical value 0.7155	M1	1.1a
	Reject H_0		
	There is evidence that the product moment correlation coefficient is greater than 0	A1ft	2.2b
		(3)	
(e)	This suggests that on average (female hook-billed) kites with longer tails have longer wings.	B1	3.2a
		(1)	
			(8 marks)

Notes:
(a) B1: for a correct definition of extrapolation B1: for a correct statement of the dangers of extrapolation
(b) B1: for a correct statement
(c) B1: for awrt 0.763
(d) B1: for both hypotheses in terms of ρ M1: for selecting a suitable 1% critical value compatible with their H_1 A1: for correct conclusion stated ft their (c) provided $-1 \leq r \leq 1$
(e) B1: for correct interpretation in context ft their (d) provided $-1 \leq r \leq 1$

Question	Scheme	Marks	AOs
3(a)	$\frac{82}{65+82+231+262} \times 100\ (= 12.8125)$	M1	1.1b
	13	A1	1.1b
		(2)	
(b)(i)	$[F = \text{faulty}, T = \text{tests positive}]\ \ \mathrm{P}(F\|T) = \frac{\mathrm{P}(F \cap T)}{\mathrm{P}(T)}$	M1	3.1b
	$\mathrm{P}(F \cap T) = 0.02 \times 0.7\ [= 0.014]$	M1	1.1b
	$\mathrm{P}(T) = 0.02\ \times 0.7 + 0.98\ \times 0.1\ [= 0.112]$	M1	1.1b
	$\mathrm{P}(F\|T) = 0.125$	A1	1.1b
		(4)	
b(ii)	Most machines that test positive do not have faults therefore the company's test is not very useful oe	B1	3.2a
		(1)	
(c)	$P(A \cap B) = 0.18$	M1	2.1
	e.g. $P(A) \times P(B) = 0.35 \times 0.55 = 0.1925 \neq P(A \cap B) = 0.18$	A1	1.1b
		(2)	
(d)	$P(A \text{ or } B \text{ not both}) = 0.35 + 0.55 - 2 \times 0.18$ oe	M1	3.1b
	=0.54	A1	1.1b
		(2)	
			(10 marks)

Notes:
(a) M1: for a correct calculation for the strata size A1: for 13
(b) M1: for identifying correct calculation M1: for method for finding $P(F \cap T)$ M1: for method for finding $P(T)$ A1: a correct answer
(c) M1: for correctly finding $P(A \cap B)$ oe A1: for a fully correct explanation: correct probabilities and correct comparisons
(d) M1: for a correct expression A1: cao

Question	Scheme	Marks	AOs
4(a)	$[\mathrm{P}(T > 22) > 0.1]$ $\frac{22-16}{\sigma} = \textit{their z value}$	M1	3.4
	1.28155….	B1	1.1b
	$\frac{22-16}{1.28155\ldots} = 4.6818\ldots$ $\cong 4.68$	A1	1.1b
		(3)	
(b)	$\mathrm{P}(L < 13) = \mathrm{P}\left(Z < \frac{13-16}{4.68}\right)$ = 0.2607… 26.1%	B1	1.1b
		(1)	
(c)	$\mathrm{P}(S > 17) = 0.2$ or $\mathrm{P}(S < 8) = 0.1$		
	$\therefore \frac{17-\mu}{\sigma} = 0.8416$ or $\therefore \frac{8-\mu}{\sigma} = -1.2816$	M1	3.4
	0.8416 and -1.2816	B1	1.1b
	$\therefore \frac{17-\mu}{\sigma} = 0.8416$ and $\therefore \frac{8-\mu}{\sigma} = -1.2816$	A1	1.1b
	$17 - \mu = 0.8416\sigma$ $-(8 - \mu = -1.2816\sigma)$	M1	1.1b
	$\sigma = 4.238\ldots$	A1	1.1b
	$\mu = 13.432\ldots$	A1	1.1b
		(6)	
(d)	$\mu = 13.4 < 16$	B1	2.4
	Yes, supports supervisor's belief		
		(1)	
			(11 marks)

Notes:
(a) M1: for a suitable equation to find σ with attempt at a z value B1: for awrt 1.28 A1: for a complete solution showing that σ is 4.68 to 3 significant figures cso
(c) B1: for 0.842 and -1.28 or better 2nd M1: for a method to solve simultaneous equations A1: for awrt $\sigma = 4.24$ A1: for awrt $\mu = 13.4$ Ignore units
(d) B1: for a suitable comparison of mean and conclusion

Question	Scheme	Marks	AOs
5(a)	W = number of scratch cards out of 20 that win, $W \sim \mathrm{B}(20,0.45)$	B1	3.3
	S=number of stores with at least 12 winning cards $S \sim \mathrm{B}(8,p)$	M1	3.1b
	$p = \mathrm{P}(W \geq 12) = 0.130765$	A1	3.4
	$1 - [\mathrm{P}(S = 1) + \mathrm{P}(S = 0)]$	M1	3.4
	So $\mathrm{P}(S \geq 2) = 0.2818 \ldots$	A1	1.1b
		(5)	
(b)	Number of trials is large and probability of success is close to 0.5	B1	1.2
		(1)	
(c)	$X \sim \mathrm{N}(135, 74.25)$	B1, B1	1.1b,1.1b
	$\mathrm{P}(X < 122.5) = \mathrm{P}\left(Z < \frac{122.5-135}{\sqrt{74.25}}\right)$	M1	3.4
	$= 0.0734 \ldots$	A1	1.1b
		(4)	
(d)	The probability is greater than 0.025 therefore there is insufficient evidence at the 5% significance level to suggest that the proportion is different from 45%	B1	2.2b
		(1)	
			(11 marks)

Notes:
(a) B1 may be implied by subsequent working 1st M1: for selection of appropriate model for *S* 1st A1: for a correct values of the parameter *p* 2nd A1: for awrt 0.282
(b) B1: both correct conditions Accept *n* is large, $np > 5$ and $n(1-p) > 5$
(c) B1: for correct mean B1: for correct variance M1: for continuity correction A1 awrt 0.0734
(d) B1: for correct statement