Pearson Edexcel

Mark Scheme

Mock Set 3

Pearson Edexcel GCE
In Mathematics (9MA0)
Paper 31 Statistics

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- 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.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- 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 may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS
General Instructions for Marking

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

2. The Edexcel Mathematics 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
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- $*$ The answer is printed on the paper
- ⎾ The second mark is dependent on gaining the first mark

4. 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.

5. 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.

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

7. 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.

Question	Scheme	Marks	AOs
1(a)(i)	$X \sim \text{Bin}(11, 0.4)$	M1	3.3
	$\text{P}(X = 2) = 0.088683...$ awrt 0.0887	A1	1.1b
(ii)	$\text{P}(X \geqslant 5) = 1 - \text{P}(X \leqslant 4) =$	M1	1.1b
	$1 - 0.53277\ldots = 0.4672\ldots$ awrt 0.467	A1	1.1b
		(4)	
(b)(i)	$\mu = np = 300 \times 0.4$ or $\sigma^2 = npq = 300 \times 0.4 \times 0.6$	M1	3.3
	$\mu = 120$ and $\sigma^2 = 72$ or $\text{N}(120, 72)$	A1	1.1b
		(2)	
(ii)	$(\text{N}(120, 72))$		
	$\text{P}(X > 134.5) =$	M1	3.4
	0.04374… awrt 0.0437	A1	1.1b
		(2)	
			(8 marks)

Notes:

(a)
(i)
M1: Use of binomial seen or implied
A1: awrt 0.0887
(ii)
M1 a correct probability statement seen or implied
A1 awrt 0.467

(b)(i)
M1: Correct expression for mean **or** variance
A1: Both values correct
(ii)
M1: use of a continuity correction (134.5 or 135.5)
A1: awrt 0.0437
Note exact binomial gives 0.044346… which is M0A0

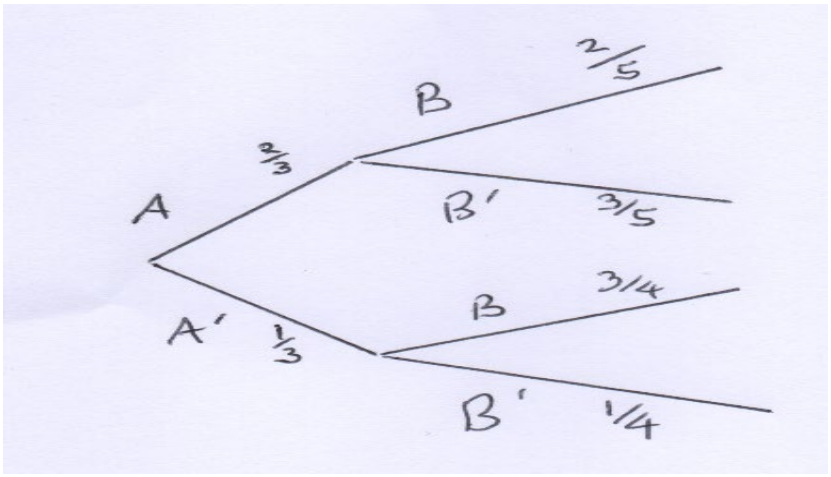
Question	Scheme	Marks	AOs
2(a)(i)	$Q_2 = 11$	B1	1.1b
(ii)	Range = (21 – 4) = 17	B1	1.1b
		(2)	
(b)	$H_0 : \rho = 0 \quad H_1 : \rho < 0$	B1	2.5
	cv = –0.5214	M1ft	1.1b
	– 0.9286 < – 0.5214 so in critical region Sufficient evidence to reject H_0 and supports Xiang's belief.	A1	2.2b
		(3)	
(c)	(As temperatures are increasing) improving scores would have opposite affect so this result gives stronger evidence for her belief.	B1	2.4
		(1)	
			(6 marks)

Notes:

(a)(i)
B1: cao 11
(ii)
B1: cao 17

(b)
B1: must be in terms of ρ
M1: ft on their H_1 (2 tail cv would be ± 0.6021)
A1: need correct conclusion in context, consistent with their cv

(c)
B1: any comment which suggests stronger evidence for her belief.

Question	Scheme	Marks	AOs
3(a)	$\mathrm{P}(A)=\frac{2}{5}+\frac{4}{15}=\frac{2}{3}$ or $\mathrm{P}(B)=\frac{1}{4}+\frac{4}{15}=\frac{31}{60}$	B1	1.1b
	$\mathrm{P}(A)\times\mathrm{P}(B)=\text{'}\frac{2}{3}\text{'}\times\text{'}\frac{31}{60}\text{'}$	M1	1.1b
	$=\frac{31}{90}\neq\frac{4}{15}=\mathrm{P}(A\cap B)$ so A and B not independent	A1	2.4
		(3)	
(b)	$\mathrm{P}(B\mid A')=\frac{\mathrm{P}(B\cap A')}{\mathrm{P}(A')}=\frac{\frac{1}{4}}{\frac{1}{4}+\frac{1}{12}}$	M1	1.1b
	$=\frac{3}{4}$	A1	1.1b
		(2)	
(c)		B1ft B1ft	1.1b 1.1b
	$\mathrm{P}(B\mid A)=\frac{\frac{4}{15}}{\frac{4}{15}+\frac{2}{5}}$ or $\mathrm{P}(B'\mid A)=\frac{\frac{2}{5}}{\frac{4}{15}+\frac{2}{5}}$	M1	3.1a
	All correct	A1	1.1b
		(4)	
			(9 marks)

Notes:

(a)

B1: either $\mathrm{P}(A)$ or $\mathrm{P}(B)$ correct

M1: use of $\mathrm{P}(A)\times\mathrm{P}(B)=\mathrm{P}(A\cap B)$ independence rule

A1: fully correct explanation supported by correct calculated values

Alt method

M1: use of eg $\mathrm{P}(A \mid B) = \mathrm{P}(A)$ or $\mathrm{P}(B \mid A) = \mathrm{P}(B)$

A1: $\mathrm{P}(A \mid B) = \frac{16}{31} \neq \frac{2}{3}$ or $\mathrm{P}(B \mid A) = \frac{2}{5} \neq \frac{31}{60}$ and correct conclusion

(b)

M1: use of $P(B \mid A') = \frac{\mathrm{P}(B \cap A')}{\mathrm{P}(A')}$ at least one of numerator or denominator correct

A1: cao, just 0.75 oe is M1A1

(c)

B1ft: $'P(A)'$ and $\mathrm{P}(A') = 1 - 'P(A)'$

B1ft: $\mathrm{P}(B \mid A')$ and $\mathrm{P}(B' \mid A')$ ft their (b)

M1: valid method to find $\mathrm{P}(B \mid A)$ or $\mathrm{P}(B' \mid A)$

A1: all correct cao

Question	Scheme	Marks	AOs
4(a)	Opportunity or convenience sampling	B1	1.1b
		(1)	
(b)	Rainfall on consecutive days may not be **independent**	B1	2.3
		(1)	
(c)	trace or less than 0.05 (mm)	B1	1.2
	e.g. Use 0 (mm)	M1	1.1b
	e.g. Would underestimate mean value as $0 < \text{tr} < 0.05$	A1	2.4
		(3)	
(d)	$\frac{7\times0+10\times0.5+2\times2+7\times5+4\times11}{30}$	**M1**	1.1b
	$=\frac{88}{30}=2.933...$ awrt 2.93	**A1**	1.1b
		(2)	
(e)	$\sum x^2 = 10\times0.5^2+2\times2^2+7\times5^2+4\times11^2 \ (=669.5)$	**M1**	1.1b
	$S_{xx} = '669.5' - \frac{'88'^2}{30} = 411.366...$ awrt 411.4*	**M1** **A1***	2.1 1.1b
		(3)	
(f)	$\sigma = \sqrt{\frac{411.4}{30}} = 3.70...$	**M1**	1.1b
	$\bar{x}-3\sigma = -8.17...$ and $\bar{x}+3\sigma = 14.042...$	**A1ft**	3.4
	So possible outliers in the $7 < x \leqslant 15$ group	**A1ft**	2.2b
		(3)	
			(13 marks)

Notes:

(a)
B1: cao

(b)
B1: must mention independence **in context**, accept suggestion that probability of rainfall at 6 am may not be constant. (again must be **in context**)

(c)
B1: if upper bound given units not required
M1: rounding to 0

A1: underestimate oe

Alternate 1

M1: place tr values in $0 < x \leqslant 1$ class or $0 < x \leqslant ?$ class (as grouped table not yet introduced.)

A1: would give overestimate oe

Alternate 2

M1: use 0.025 mm

A1: little or no impact on mean value.

(d)

M1: use of $\sum fx$ with at least 2 values of x correct

A1: awrt 2.93

(e)

M1: $\sum x^2 = ...$ Attempted with at least 2 terms correct may be implied by awrt 670 in working

M1: evidence of correct formula used for S_{xx}

A1*: sight of 411.36… or better

(f)

M1: use of correct formula for σ (accept s = 3.766…)

A1ft: at least one correct limit seen (use of s gives $-8.366...$ and 14.232…) ft on their $\bar{x}$ if between 2 & 4

A1ft: condone no mention of lower limit if no errors seen, ft on their $\bar{x}$ if between 2 & 4

Question	Scheme	Marks	AOs
5(a)	$\left[X \sim \mathrm{N}\left(443, 6^2\right)\right]$		
	$\mathrm{P}\left(X < 440\right) =$	M1	3.4
	0.30853… awrt 0.309	A1	1.1b
		(2)	
(b)	$\mathrm{P}\left(X < 435 \cup X > 445\right) = 1 - \mathrm{P}\left(435 < X < 445\right)$ oe $= 1 - 0.53934...$	M1	3.1b/ 3.4?
	0.46065… awrt 0.461	A1	1.1b
		(2)	
(c)	$\mathrm{H}_0 : \mu = 443 \quad \mathrm{H}_1 : \mu < 443$	B1	2.5
	$\bar{X} \sim \mathrm{N}\left(443, \frac{4.5^2}{20}\right)$	M1	3.3
	p value = 0.16015… (> 0.05)	dM1	3.4
	Not in critical region, insufficient evidence to reject H_0, no significant evidence to support Kim's claim	A1	2.2b
		(4)	
(d)	Standardising, $\frac{438 - \mu}{\sigma} = -0.8416$ And $\frac{445 - \mu}{\sigma} = 1.2816$	M1 M1 B1 A1	3.1b 3.4 1.1b 1.1b
	Solving simultaneous equations $\mu = 440.77... = 440.8$ Hz cao $\sigma = 3.296... = 3.3$ Hz cao	M1 A1	1.1b 1.1b
		(6)	
			(14 marks)

Notes:

(a)

M1: attempt to use model with correct inequality

A1: awrt 0.309

(b)

M1: Use of $1 - \mathrm{P}\left(435 < X < 445\right)$ or $\mathrm{P}\left(X < 435\right) + \mathrm{P}\left(X > 445\right)$

If answer incorrect M1 could be given for sight of 0.539 … or 0.0912 **and** 0.369

A1: awrt 0.461

(c)

B1: hypotheses must be in terms of μ

M1: allow variance of $4.5^2/20$ but not just 4.5 or 4.5^2

dM1: dependent on previous M1, *p* value awrt 0.16

Alt method; Test statistic $z = \dfrac{442-443}{\dfrac{4.5}{\sqrt{20}}} = -0.9938...$ and critical value $z = (-)1.645$ or better

A1: correct conclusion in context, must mention **Kim's claim** or **mean frequency**

(d)

M1: attempt to standardise at least one of 438 and 445

M1: one equation formed condone sign errors

B1: $(-)0.8416$ or 1.2816 (or better) seen or implied

A1: both equations correct including signs

M1: solving their simultaneous equations

A1: 440.8 and 3.3 cao