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Mark Scheme (Results)

January 2012

GCE Statistics S2 (6684) Paper 1

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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 75.

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 and can be used if you are using the annotation facility on ePEN.

- 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
- $\sqsubset$ The second mark is dependent on gaining the first mark

4. All 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 manifestly absurd answers should never be awarded A marks.

General Principals for Core Mathematics Marking

(But note that specific mark schemes may sometimes override these general principles).

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q),$ where $|pq| = |c|$, leading to x = ...

$(ax^2 + bx + c) = (mx + p)(nx + q),$ where $|pq| = |c|$ and $|mn| = |a|$, leading to x = …

2. Formula

Attempt to use correct formula (with values for a, b and c), leading to x = …

3. Completing the square

Solving $x^2 + bx + c = 0$: $\left(x \pm \frac{b}{2}\right)^2 \pm q \pm c, \quad q \neq 0$, leading to x = …

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. ($x^n \rightarrow x^{n-1}$)

2. Integration

Power of at least one term increased by 1. ($x^n \rightarrow x^{n+1}$)

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.
Normal marking procedure is as follows:
Method mark for quoting a correct formula and attempting to use it, even if there are mistakes in the substitution of values.
Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

January 2012
6684 Statistics S2
Mark Scheme

Question Number	Scheme	Marks
1 (a)	$\mathrm{E}(X)=\frac{9+3}{2}=6$	B1 (1)
(b)	$\mathrm{Var}(X)=\frac{(9-3)^2}{12}=3$	M1A1 (2)
(c)	$\mathrm{P}(X>7)=(9-7)\times\frac{1}{6}=\frac{1}{3}$	M1A1 (2)
(d)	$\mathrm{P}(X<6 \mid X>4)=\frac{\mathrm{P}(4<X<6)}{\mathrm{P}(X>4)}$ $=\frac{\frac{2}{6}}{\frac{5}{6}}=\frac{2}{5}$	M1A1 A1 (3) **8**
	Notes	
(b)	M1 $\frac{(9-3)^2}{12}$ or $\frac{(9+3)^2}{12}$	
(c)	M1 $\frac{(9-7)}{6}$ or $1-\frac{(7-3)}{6}$ or $\int_7^9 \frac{1}{6}\,dx$ or $1-\int_3^7 \frac{1}{6}\,dx$ A1 Also acceptable $0.\dot{3}$, $0.3\dot{3}$ and awrt 0.333	
(d)	M1 $\frac{\mathrm{P}(4<X<6)}{P(X>4)}$ or $\frac{\mathrm{P}(X<6)}{P(X>4)}$ or $\frac{2/6}{5/6}$ or $\frac{3/6}{5/6}$ or $1-\frac{\mathrm{P}(X>6)}{P(X>4)}$ or $\frac{6-4}{9-4}$ or $\frac{3}{5}$ A1 $\frac{\mathrm{P}(4<X<6)}{P(X>4)}$ or $\frac{2/6}{5/6}$ or $1-\frac{\mathrm{P}(X>6)}{P(X>4)}$ or $\frac{6-4}{9-4}$ An answer of $\frac{2}{5}$ gains all 3 marks. NB $\leq$ and $\geq$ are accepted in the above formulae	

Question Number	Scheme	Marks
2	$H_0 : p = 0.5$	B1
	$H_1 : p > 0.5$	B1
	$X \sim B(30,0.5)$ Using correct Bin	M1
	$P(X \geq 21) = 1 - P(X \leq 20)$ or $P(X \leq 19) = 0.9506$ $P(X \geq 20) = 0.0494$	M1
	$= 1 - 0.9786$	
	$= 0.0214$ CR $X \geq 20$	A1
	so significant/reject H_0 /in Critical region	M1 dep
	Evidence to suggest **<u>David's claim is incorrect</u>**	A1
	or The weather **<u>forecast</u>** produced by the local **<u>radio</u>** is better than those achieved by **<u>tossing/flipping a coin</u>**	(7)
		7

Notes

1st B1 for $H_0 : p = 0.5$
2nd B1 for $H_1 : p > 0.5$
SC If both hypotheses are correct but a different letter to p is used they get B1 B0. If no letter is used they get B0 B0.

1st M1 writing or using B(30,0.5)
<u>One tail</u>
2nd M1 for writing or using 1 - P($X \leq 20$) or writing P($X \leq 19$) = 0.9506 or P($X \geq 20$) = 0.0494. May be implied by correct CR.or probability = 0.0214
A1 for 0.0214 or CR $X \geq 20$/ $X > 19$. **NB** P($X \leq 20$) = 0.9786 on its own scores M1A1
3rd M1 dependent on the 2nd M1 being awarded. For a correct statement based on the table below. Do not allow non-contextual conflicting statements eg "significant" and "accept H_0". **Ignore comparisons**.
2nd A1 for a correct contextualised statement. NB A correct contextual statement on its own scores M1A1.

	$0.05 < p < 0.95$	$p < 0.05$ or $p > 0.95$
3rd M1	not significant/ accept H_0/ Not in CR	significant/ reject H_0/ In CR
2nd A1	David's claim is correct weather **<u>forecast</u>** produced by the local **<u>radio</u>** is no better than those achieved by **<u>tossing/flipping a coin</u>**	David's claim incorrect weather **<u>forecast</u>** produced by the local **<u>radio</u>** is better than those achieved by **<u>tossing/flipping a coin</u>**

<u>Two tail</u>
1st M1 for writing or using 1 - P($X \leq 20$) or writing P($X \leq 20$)= 0.9786 or P($X \geq 21$) = 0.0214. May be implied by correct CR. or probability = 0.197
A1 for 0.0214 or CR $X \geq 21$/ $X > 20$. **NB** P($X \leq 20$) = 0.9786 on its own scores M1A1
3rd M1 dependent on the 2nd M1 being awarded . For a correct statement based on the table below. Do not allow non-contextual conflicting statements eg"significant" and "accept H_0" . **Ignore comparisons**.
2nd A1 for a correct contextualised statement. NB A correct contextual statement on its own scores M1A1.

	$0.025 < p < 0.975$	$p < 0.025$ or $p > 0.975$
3rd M1	not significant/ accept H_0/ Not in CR	significant/ reject H_0/ In CR
2nd A1	David's .claim is correct weather **<u>forecast</u>** produced by the local **<u>radio</u>** is no better than those achieved by **<u>tossing/flipping a coin</u>**	David's claim incorrect weather **<u>forecast</u>** produced by the local **<u>radio</u>** is better than those achieved by **<u>tossing/flipping a coin</u>**

Question	Scheme	Marks

Number		
3 (a)	$P(X = 0) = 0.85^{10}$ or from tables	M1
	$= 0.1969$ awrt 0.197	A1
		(2)
(b)	$P(X > 3) = 1 - P(X \leq 3)$	M1
	$= 1 - 0.6477$	
	$= 0.3523$ awrt 0.352	A1
		(2)
(c)	$n \times 0.15 = 5$	M1
	$n = 33$ or 34	A1
		(2)
(d)	1 - P(X = 0) > 0.95	M1
	$1 - (0.85)^n > 0.95$.	A1
	$0.85^n < 0.05$	
	$n > 18.4$	
	$n = 19$	A1
		(3)
		9

Notes

(a) M1 $(p)^{10}$ with $0 < p < 1$

(b) M1writing or using 1 - P($X \leq 3$)

(c) M1 $np = 5$ $0 < p < 1$

(d) M1 writing or using 1 - P(X = 0) > 0.95 or P(X = 0) < 0.05 (also accepted are = or $\geq$ instead of > and = or $\leq$ instead of or <) P($X \leq 0$) is equivalent to P(X =0)
A1 writing or using 1 - $(0.85)^n > 0.95$ or $(0.85)^n < 0.05$ (also accepted are $\geq$ instead of > and $\leq$ instead of or <). Any value of n may be used
A1 cao

NB an answer of 18.4 gets M1 A1 A0

An answer of 19 gets M1 A1 A1 unless it follows from clearly incorrect working.

Question Number	Scheme	Marks
4 (a)	Poisson	B1 (1)
(b)	Hits occur **singly** in time Hits are **independent <u>or</u>** Hits occur **randomly** Hits occur at a **constant rate**	B1B1 (2)
(c)	$X\sim$ Po(5)	B1
	$P(X=10) = \mathrm{P}(X\le 10) - \mathrm{P}(X\le 9)$ or $\frac{e^{-5}5^{10}}{10!}$	M1
	$= 0.9863 - 0.9682$ $= 0.0181$ awrt 0.0181	A1 (3)
(d)	$X\sim$ Po(10)	B1
	$\mathrm{P}(X\ge 15) = 1-\mathrm{P}(X\le 14)$	M1
	$=1-0.9165$ $=0.0835$ awrt 0 .0835	A1 (3)
(e)	$X\sim$ Po(50) Approximated by N(50,50)	B1B1
	$\mathrm{P}(X>70) = \mathrm{P}\left(Z > \frac{70.5-50}{\sqrt{50}}\right)$	M1M1
	$= \mathrm{P}(Z > 2.899...)$	A1
	$=1-0.9981$	M1
	$=0.0019$ awrt 0.0019	A1 (7) **16**

Notes

(b) 1st B1 Any one of the 3 statements - no context required. NB It must be a constant (mean) rate and not a constant probability or a constant mean.
2nd B1 A different statement with context of **<u>hits.</u>** NB random and independent are the same statement.
If only one mark awarded give the 1st B1. Never award B0 B1

(c) B1 writing or using Po(5)

M1 writing or using $\mathrm{P}(X\le 10) - \mathrm{P}(X\le 9)$ or $\frac{e^{-5}5^{10}}{10!}$

(d) B1 writing or using Po(10)
M1 writing or using 1- $\mathrm{P}(X\le 14)$

(e) 1st B1 for a normal approximation 2nd B1 for correct mean and sd (may be seen in standardisation formula
1st M1 for attempting a continuity correction (71 ± 0.5)
2nd M1 Standardising using their mean and their sd and using [69.5, 70, 70.5, 71 or 71.5] allow $\pm$ z
NB if they have not written down a mean and sd then they need to be correct in the standardisation to gain this mark.

1st A1 for $z = \pm$ awrt 2.9 or better. May be awarded for $\pm\frac{70.5-50}{\sqrt{50}}$

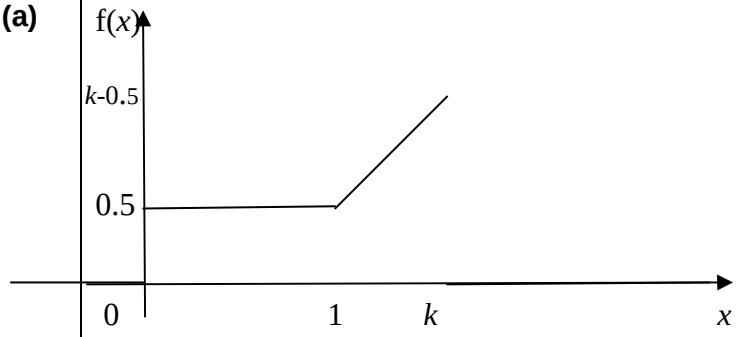
3rd M1 for 1 - tables value

SC using P(X< 70.5/71.5) – P(X<69.5/70.5) can get B1B1 M0M1A0 M0A0

Question Number	Scheme	Marks
5 (a)	$X \sim B(120,0.075)$	B1
	Approximated by Po(9)	M1A1
	$P(X > 3) = 1 - P(X \leq 3)$	M1
	$= 1 - 0.0212$	
	$= 0.9788$ awrt 0.979	A1
		(5)
(b)	P(At least 4 defective components in each box)	
	$= P(X > 3) \times P(X > 3)$	M1
	$= 0.9788^2$	
	$= 0.95804944$ awrt 0.958	A1
		(2)
		7
	Notes	
(a)	B1 Writing or use of B(120,0.075) may be implied by using Po(9) or N(9,8.325)	
	1st M1 writing or use of Poisson	
	1st A1 writing or use of Po(9)	
	2nd M1 for writing or using 1- P($X \leq 3$) or this may be implied by an awrt 0.972 using normal approximation.	
(b)	M1 ((their (a))^2 or 0.979^2 or 0.9788^2 or 0.98^2	

Question Number	Scheme	Marks

6 (a)



shape B1
labels B1

(2)

(b)

$\int_1^k \left(x-\frac{1}{2}\right)\mathrm{d}x = \frac{1}{2}$ M1

$\left[\frac{1}{2}x^2-\frac{1}{2}x\right]_1^k = \frac{1}{2}$

$k^2-k-1=0$ o.e. A1

$k=\frac{1}{2}\left(1+\sqrt{5}\right)$ M1A1 cso

(4)

(c)

$$F(x)=\begin{cases}0, & x<0\\ \frac{1}{2}x, & 0\le x<1\\ \frac{1}{2}x^2-\frac{1}{2}x+\frac{1}{2}, & 1\le x\le k\\ 1, & x>k\end{cases}$$

B1

M1A1A1B1

B1 1st and last

(6)

Note: Working for the M1A1A1

$\int_1^k x-\frac{1}{2}\mathrm{d}x + \mathrm{C} = \frac{1}{2}x^2-\frac{1}{2}x\ ;+\frac{1}{2}$ (M1A1;A1)

(d)

$\mathrm{P}(0.5<X<1.5) = \mathrm{F}(1.5)-\mathrm{F}(0.5)$
$= 0.875 - 0.25$ M1
$= 0.625$ A1

(2)

(e)

Median is $x=1$ B1

Mode is $x=k$ or $\frac{1}{2}(1+\sqrt{5})$ or awrt1.62 B1

(2)

(f)

Negative skew B1
Median<mode or from graph more values are to the right. B1d

(2)

18

(a)

Notes

1st B1 Correct shape with straight lines. Must all be above the *x*-axis

2nd B1 A fully correct graph with the labels 1, *k*, 0.5, *k* - 0.5 seen in the correct places.

Allow the use of $\frac{1}{2}(1+\sqrt{5})$ /awrt 1.62 instead of *k*.

(b)	1st M1 $\int_1^k x-\frac{1}{2}\,\mathrm{d}x = 0.5$ or $\int_1^k x-\frac{1}{2}\,\mathrm{d}x + 0.5 = 1$ ignore limits or $\int_1^k x-\frac{1}{2}\,\mathrm{d}x + \int_1^k \frac{1}{2}\,\mathrm{d}x = 1$ or $\frac{1}{2}(k-0.5+0.5)(k-1) = 0.5$ or any correct method of finding the area 1st A1 for a quadratic equation in the form $a(k^2 - k - 1) = 0$ or $ak^2 - ak = a$. where a is a constant. 2nd M1 correct method for solving a quadratic of the form $ak^2 - bk + c = 0$ where $a,b,c \neq 0$. There must be at least one correct step before the final answer. Allow substituting in k into a quadratic of the form $ak^2 - bk + c = 0$. 2nd A1 cso for $k = \frac{1}{2}\left(1+\sqrt{5}\right)$	
(c)	1st B1 for second line. Do not penalise the use of < instead of $\leq$ and vice versa M1 for use of $\int_1^k x-\frac{1}{2}\,\mathrm{d}x$ + C ignore limits. For use they must have $x \rightarrow x^2$ 1st A1 correct integration $\frac{1}{2}x^2 - \frac{1}{2}x$ 2nd A1 C = $\frac{1}{2}$ NB M1A1A1 may be implied by correct 3rd line in F(x) 2nd B1 for 3rd line. Statement of the form $\frac{1}{2}x^2 - \frac{1}{2}x \pm C$. Do not penalise the use of < instead of $\leq$ and vice versa. Allow k or value of k. C may equal 0. 3rd B1 for first and last line. Do not penalise the use of $\leq$ instead of < and $\geq$ instead of >. Allow k or value of k	
(d)	M1 **Using** F(1.5) - F(0.5) . 1.5 must be put into the third line of the c.d.f. and 0.5 must be put into the second line of the c.d.f.. or $\int_{0.5}^{1} \frac{1}{2}x\,\mathrm{d}x + \int_1^{1.5} x-\frac{1}{2}\,\mathrm{d}x$ need to attempt integration, at least one $x^n \rightarrow x^{n+1}$ or seeing 0.25 + 0.375 or any correct method of finding the area.. (NB if they have not used + C or C = 0 they will get 0.125. This will get M1A0). An answer of 0.125 from an incorrect method gains M0 A0.	
(e)	If it is not clear which one is the mode and which one is the median assume the median is the first answer and mode the second.	
(f)	B1 negative/negative skew(ness). Do not allow negative correlation. B1 dependent on previous B mark being awarded. Reason must follow from their values or diagram.	

Question Number	Scheme	Marks
7 (a) (i)	The **range of values/region/area/set of values** of the test statistic that would lead you to **reject H_0**	B1
(a) (ii)	The probability of incorrectly rejecting H_0 or Probability of rejecting H_0 when H_0 is true	B1 (2)

(b) (i)	$X \sim$Po(8)	M1	
	$P(X \leq 4) = 0.0996$ $P(X \leq 3) = 0.0424$		
	Critical region [0,3]	A1	
(b) (ii)	awrt 0.0424	B1	(3)
(c)	$H_0 : \lambda = 8$ (or μ =8)	B1	
	$H_1 : \lambda > 8$ (or μ >8)		
	$P(X \geq 13) = 1 - P(X \leq 12)$ or $P(X \leq 13) = 0.9658$ or $P(X \geq 14) = 0.0342$	M1	
	$= 1 - 0.9362$		
	$= 0.0638$ CR $X \geq 14$	A1	
	so insufficient evidence to reject H_0 /not significant/ not in critical region	M1 dep	
	There in insufficient evidence of an increase/change in the **rate/number** of sales per month **or** the estate **agents** claim is incorrect	A1	(5)
			10

Notes

(a)(i) Allow accept H_1 instead of reject H_0. It must be clear which hypothesis gets rejected/accepted.

(ii) Allow equivalent wording.

(b) M1 Writing or using Po(8). May be implied by correct critical region.

A1 allow $0 \leq X \leq 3$ or CR ≤ 3 or $X \leq 3$. Any letter may be used but not $P(X \leq 3)$. This must be on its own.

(c) B1 both hypotheses correct. Must use λ or μ.

One tail

1st M1 for writing or using 1 - $P(X \leq 12)$ or writing $P(X \leq 13) = 0.9658$ or $P(X \geq 14) = 0.0342$. May be implied by correct CR.or probability = 0.0638

A1 for 0.0638 or $X \geq 14$. Allow $X > 13$. NB $P(X \leq 12) = 0.9362$ on its own scores M1A1

2nd M1 dependent on the 1st M1 being awarded. For a correct statement based on the table below. Do not allow non-contextual conflicting statements eg "not significant" and "reject H_0". **Ignore comparisons**.

2nd A1 for a correct contextualised statement. NB A correct contextual statement on its own scores M1A1.

	$0.05 < p < 0.95$	$p < 0.05$ or $p > 0.95$
2nd M1	not significant/ accept H_0/ Not in CR	significant/ reject H_0/ In CR
2nd A1	Insufficient evidence of an increase/change in the **rate/number** of sales per month	Sufficient evidence of an increase/change in the **rate/number** of sales per month

Two tail

1st M1 for writing or using 1 - $P(X \leq 12)$ or writing $P(X \leq 14) = 0.9827$ or $P(X \geq 15) = 0.0173$. May be implied by correct CR.or probability = 0.0638

A1 for 0.0638 or $X \geq 15$. Allow $X > 14$. NB $P(X \leq 12) = 0.9362$ on its own scores M1A1

2nd M1 dependent on the 1st M1 being awarded . For a correct statement based on the table below. Do not allow non-contextual conflicting statements eg "not significant" and "reject H_0".**Ignore comparisons**.

2nd A1 for a correct contextualised statement. NB A correct contextual statement on its own scores M1A1.

	$0.025 < p < 0.975$	$p < 0.025$ or $p > 0.975$
2nd M1	not significant/ accept H_0/ Not in CR	significant/ reject H_0/ In CR
2nd A1	Insufficient evidence of an increase/change in the **rate/number** of sales per month	Sufficient evidence of an increase/change in the **rate/number** of sales per month

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