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Mark Scheme (Final)
January 2008

GCE

GCE Mathematics (6684/01)

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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.

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190 High Holborn London WC1V 7BH

January 2008

Advanced Subsidiary/Advanced Level

General Certificate of Education

Subject: **Statistics 2** **Paper: S2**

Question Number	Scheme Marks	
1. (a)	A census is when <u>every member</u> of the <u>population</u> is investigated.	B1
(b)	There would be no cookers left to sell.	B1
(c)	A list of the unique identification numbers of the cookers.	B1
(d)	A cooker	B1
		(4)
Notes 1. (a)	**B1** Need one word from each group (1) <u>Every member /all items / entire /oe</u> (2) <u>population/collection of individuals/sampling frame/oe</u> enumerating the population on its own gets B0	
(b)	**B1** Idea of Tests to destruction. Do not accept cheap or quick	
(c)	**B1** Idea of list/ register/database of cookers/serial numbers	
(d)	**B1** cooker(s) / serial number(s) The sample of 5 cookers or every 400^{th} cooker gets B1	

2. (a)	Let X be the random variable the number of faulty bolts	
	$P(X \leq 2) - P(X \leq 1) = 0.0355 - 0.0076$ = 0.0279 or $(0.3)^2(0.7)^{18}\frac{20!}{18!2!}$ = 0.0278	M1 A1 (2)
(b)	$1 - P(X \leq 3) = 1 - 0.1071$ = 0.8929	M1 A1 (2)
	or $1-(0.3)^3(0.7)^{17}\frac{20!}{17!3!}-(0.3)^2(0.7)^{18}\frac{20!}{18!2!}-(0.3)(0.7.)^{19}\frac{20!}{19!1!}-(0.7)^{20}$	
(c)	$\frac{10!}{4!6!}(0.8929)^6(0.1071)^4$ = 0.0140.	M1A1√A1 (3)

Notes

2. (a)

M1 Either
attempting to use P ($X \leq 2$) – P ($X \leq 1$)

or attempt to use binomial and find p($X = 2$). Must have $(p)^2(1-p)^{18}\frac{20!}{18!2!}$,
with a value of p

A1 awrt 0.0278 or 0.0279.

(b)

M1 Attempting to find $1 - P(X \leq 3)$

A1 awrt 0.893

(c)

M1 for $k\ (p)^6(1-p)^4$. They may use any value for p and k can be any number or ${}^nC_6p^6(1-p)^{n-6}$

A1√ $\frac{10!}{4!6!}(their\ part\ b)^6(1-their\ part\ b)^4$ may write ${}^{10}C_6$or ${}^{10}C_4$

A1 awrt 0.014

3. (a)	Events occur at a constant rate. any two of the 3 Events occur independently or randomly. Events occur singly.	B1 B1 (2)
(b)	Let X be the random variable the number of cars passing the observation point.	
(i)	Po(6) $P(X \leq 4) - P(X \leq 3) = 0.2851 - 0.1512$ or $\frac{e^{-6}6^4}{4!}$ $= 0.1339$	B1 M1 A1
(ii)	$1 - P(X \leq 4) = 1 - 0.2851$ or $1 - e^{-6}\left(\frac{6^4}{4!}+\frac{6^3}{3!}+\frac{6^2}{2!}+\frac{6}{1!}+1\right)$ $= 0.7149$	M1 A1 (5)
(c)	P (0 car and 1 others) + P (1 cars and 0 other) $= e^{-1} \times 2e^{-2} + 1e^{-1} \times e^{-2}$ $= 0.3679 \times 0.2707 + 0.3674 \times 0.1353$ $= 0.0996 + 0.0498$ $= 0.149$ alternative $P_o(1+2) = P_o(3)$ B1 $P(X=1) = 3e^{-3}$ M1 A1 $= 0.149$ A1	B1 M1 A1 A1 (4)
Notes 3(a)	**B1 B1** Need the word events at least once. Independently and randomly are the same reason. Award the first B1 if they only gain 1 mark **Special case.** If they have 2 of the 3 lines without the word events they get B0 B1	
(b) (i)	**B1** Using Po(6) in (i) or (ii) **M1** Attempting to find $P(X \leq 4) - P(X \leq 3)$ or $\frac{e^{-\lambda}\lambda^4}{4!}$ **A1** awrt 0.134	
(ii)	**M1** Attempting to find $1 - P(X \leq 4)$ **A1** awrt 0.715	

(c)	**B1** Attempting to find both possibilities. May be implied by doing $e^{-\lambda_1} \times \lambda_2 e^{-\lambda_2} + e^{-\lambda_2} \times \lambda_1 e^{-\lambda_1}$ any values of λ_1 and λ_2 **M1** finding one pair of form $e^{-\lambda_1} \times \lambda_2 e^{-\lambda_2}$ any values of λ_1 and λ_2 **A1** one pair correct **A1** awrt 0.149 Alternative. B1 for Po(3) M1 for attempting to find P(X=1) with Po(3) A1 $3e^{-3}$ A1 awrt 0.149	

4. (a)	$K(2^4 + 2^2 - 2) = 1$ $K = 1/18$	M1 A1 (2)
(b)	$1 - F(1.5) = 1 - \frac{1}{18}(1.5^4 + 1.5^2 - 2)$ $= 0.705$ or $\frac{203}{288}$	M1 A1 (2)
(c)	$f(y) = \begin{cases} \frac{1}{9}(2y^3 + y) & 1 \le y \le 2 \\ 0 & \textit{otherwise} \end{cases}$	M1 A1 B1 (3)

Notes

4. (a)

M1 putting F(*2*) = 1 or F(*2*) – F(1) = 1
A1 cso. Must show substituting *y* = 2 and the 1/18

(b)

M1 either attempting to find 1 – F(1.5) may write and use F(2) – F (1.5)
A1 awrt 0.705

(c)

M1 attempting to differentiate. Must see either a $y^n \rightarrow y^{n-1}$ at least once

A1 for getting $\frac{1}{9}(2y^3 + y)$ o.e and $1 \le y \le 2$ allow $1 < y < 2$

B1 for the 0 *otherwise.* Allow 0 for y <1 and 0 for y >2

Allow them to use any letter

5	$H_0 : p = 0.3$; $H_1 : p > 0.3$ Let X represent the number of tomatoes greater than 4 cm : $X \sim B(40, 0.3)$ $P(X \geq 18) = 1 - P(X \leq 17)$ $P(X \geq 18)$ $1 - P(X \leq 17) = 0.0320$ $P(X \geq 17) = 1 - P(X \leq 16) = 0.0633$ $= 0.0320$ CR $X \geq 18$ $0.0320 < 0.05$ $18 \geq 18$ or 18 in the critical region no evidence to Reject H_0 or it is significant New fertiliser has <u>increased</u> the probability of a <u>tomato</u> being greater than 4 cm **Or** Dhriti's claim is true	B1 B1 B1 M1 A1 M1 B1d cao (7)
5	**B1** for correct H_0 . must use p or pi **B1** for correct H_1 must use p and be one tail. **B1** using B(40, 0.3). This may be implied by their calculation **M1** attempt to find $1 - P(X \leq 17)$ or get a correct probability. For CR method must attempt to find $P(X \geq 18)$ or give the correct critical region **A1** awrt 0.032 or correct CR. **M1** correct statement based on their probability , H_1 and 0.05 or a correct contextualised statement that implies that. **B1** this is not a follow through .conclusion in context. Must use the words increased, tomato and some reference to size or diameter. This is dependent on them getting the previous M1 If they do a **<u>two tail test</u>** they may get B1 B0 B1 M1 A1 M1 B0 For the second M1 they must have accept Ho or it is not significant or a correct contextualised statement that implies that. .	

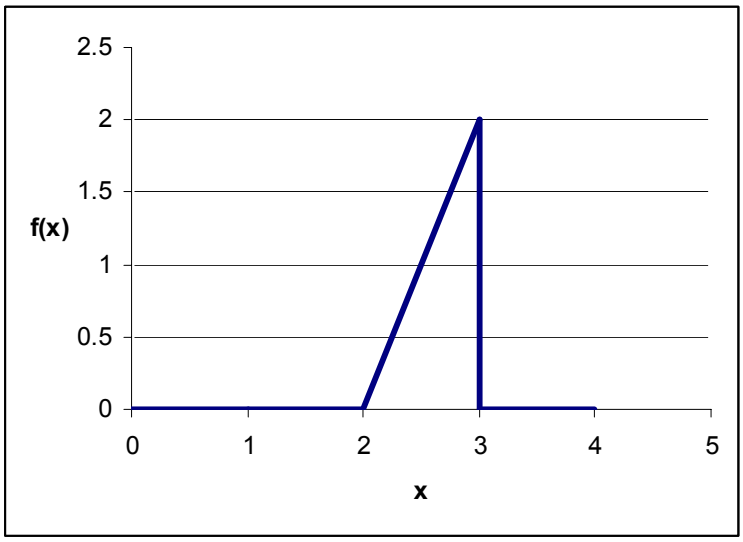
6a (i)	Let X represent the number of sunflower plants more than 1.5m high	
	X~ Po(10) μ=10	B1
	P($8 \leq X \leq 13$) = P($X \leq 13$) – P($X \leq 7$)	M1
	= 0.8645 – 0.2202	
	= 0.6443 awrt 0.644	A1
ii)	X~ N(10,7.5)	B1
	P($7.5 \leq X \leq 13.5$) = $P\left(\frac{7.5-10}{\sqrt{7.5}} \leq X \leq \frac{13.5-10}{\sqrt{7.5}}\right)$	M1 M1
	= P (-0.913 $\leq$ X $\leq$ 1.278)	A1 A1
	= 0.8997 – (1 – 0.8186)	M1
	= 0.7183 awrt 0.718 or 0.719	A1 (10)
b)	Normal approx /not Poisson since (n is large) and p close to half. **or** (np = 10 npq = 7.5) mean $\neq$ variance **or** np (= 10) and nq (= 30) both >5. or exact binomial = 0.7148	B1 B1dep (2)

6a (i)	**B1** mean = 10 May be implied in (i) or (ii)
	M1 Attempting to find P($X \leq 13$) – P($X \leq 7$)
	A1 awrt 0.644
ii)	**B1** σ^2 = 7.5 May be implied by being correct in standardised formula
	M1 using 7.5 or 8.5 or 12.5 or 13.5.
	M1 standardising using 7.5 or 8 or 8.5 **or** 12.5 or13 or 13.5 and their mean and standard deviation.
	A1 award for either $\frac{7.5-10}{\sqrt{7.5}}$ or awrt -0.91

b)	**A1** award for either $\frac{13.5-10}{\sqrt{7.5}}$ or awrt 1.28 **M1** Finding the correct area. Following on from their 7.5 and 13.5. Need to do a Prob >0.5 – prob <0.5 or prob <0.5 + prob< 0.5 **A1** awrt 0.718 or 0.719 only. Dependent on them getting all three method marks. No working but correct answer will gain all the marks first **B1** normal second **B1** p close to half, or mean $\neq$ variance or np and nq both > 5.They may use a number bigger than 5 or they may work out the exact value 0.7148 using the binomial distribution. **Do not allow np> 5 and npq>5** A hypothesis test is a mathematical procedure to <u>examine a value of</u>	

7 ai)	a population parameter proposed by the null hypothesis compared with an alternative hypothesis.	B1
ii)	The critical region is the range of values **or** a test statistic or region where the test is significant that would lead to the rejection of H_0.	B1g B1h (3)
(b)	Let X represent the number of incoming calls : $X \sim Po(9)$	B1
	From table $P(X \geq 16) = 0.0220$	M1 A1
	$P(x \leq 3) = 0.0212$	A1
	Critical region ($x \leq 3$ or $x \geq 16$)	B1 (5)
(c)	Significance level = 0.0220 + 0.0212 = 0.0432 or4.32%	B1 (1)
(d)	$H_o : \lambda = 0.45$; $H_1 : \lambda < 0.45$ (accept : $H_o : \lambda = 4.5$; $H_1 : \lambda < 4.5$)	B1
	Using $X \sim Po(4.5)$	M1
	$P(X \leq 1) = 0.0611$ CR $X \leq 0$ awrt 0.0611	A1
	0.0611 > 0.05. $1 \geq 0$ or 1not in the critical region	
	There is evidence to Accept H_0 or it is not significant	M1
	There is no evidence that there are less calls during school holidays.	B1cao (5)
Notes 7 ai)	B1 Method for deciding between 2 hypothesis.	
ii)	B1 range of values. This may be implied by other words. Not region on its own B1 which lead you to reject H_0 Give the first B1 if only one mark awarded.	
(b)	B1 using $P_o(9)$	

	M1 attempting to find $P(X \geq 16)$ or $P(x \leq 3)$ A1 0.0220 or $P(X \geq 16)$ A1 0.0212 or $P(x \leq 3)$ These 3 marks may be gained by seeing the numbers in part c B1 correct critical region A completely correct critical region will get all 5 marks. Half of the correct critical region eg $x \leq 3$ or $x \geq 17$ say would get B1 M1 A0 A1 B0 if the M1 A1 A1 not already awarded.	
(c)	B1 cao awrt 0.0432	
(d)	B1 may use λ or μ. Needs both H_0 and H_1 M1 using $P_o(4.5)$ A1 correct probability or CR only M1 correct statement based on their probability , H_1 and 0.05 or a correct contextualised statement that implies that. **B1** this is not a follow through .Conclusion in context. Must see the word **calls** in conclusion If they get the correct CR with no evidence of using $P_o(4.5)$ they will get M0 A0 SC If they get the critical region $X \leq 1$ they score M1 for rejecting H_0 and B1 for concluding the rate of calls in the holiday is lower.	

8. a)		Max height of 2 labelled and goes through(2,0) shape must be between 2 and 3 and no other lines drawn (accept patios drawn) correct shape	B1 B1 B1 (3)
b)	3		B1 (1)
c)	$\int_2^3 2x(x-2)\,dx = \left[\frac{2x^3}{3} - 2x^2\right]_2^3$ $= 2\frac{2}{3}$		M1A1 A1 (3)
d)	$\int_2^m 2(x-2)\,dx = 0.5$ $\left[x^2 - 4x\right]_2^m = 0.5$ $m^2 - 4m + 4 = 0.5$ $m^2 - 4m + 3.5 = 0$ $m = \frac{4 \pm \sqrt{2}}{2}$ $m = 2.71$		M1 A1 M1 A1 (4)
e)	Negative skew. mean < median < mode .		B1 B1dep (2)

Notes 8.		
(a)	**B1** the graph must have a maximum of 2 which must be labelled **B1** the line must be between 2 and 3 with not other line drawn except patios. They can get this mark even if the patio cannot be seen. **B1** the line must be straight and the right shape.	
(b)	**B1** Only accept 3	
(c)	**M1** attempt to find $\int xf(x)dx$ for attempt we need to see $x^n \rightarrow x^{n+1}$. ignore limits **A1** correct integration ignore limits **A1** accept $2\frac{2}{3}$ or awrt 2.67 or $2.\dot{6}$	
(d)	**M1** using $\int f(x)dx$ =0.5 **A1** $m^2 - 4m + 4 = 0.5$ oe **M1** attempting to solve quadratic. **A1** awrt 2.71 or $\frac{4+\sqrt{2}}{2}$ or $2+\frac{\sqrt{2}}{2}$ oe	
(e)	First **B1** for negative Second **B1** for mean < median< mode. Need all 3 or may explain using diagram.	