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Mark Scheme (Results)
January 2011

GCE

GCE Statistics S2 (6684) Paper 1

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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.

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

January 2011
Statistics S2 6684
Mark Scheme

Question Number	Scheme	Marks
1. **(a)**	Occurrences of the disease are independent The probability of catching the disease remains constant.	B1 B1 (2)
(b)	$X \sim \text{Bin}(10,0.03)$ $\text{P}(X=2)=\frac{10\times 9}{2}(0.03)^2(0.97)^8=0.0317$	B1 M1A1 (3)
(c)	$\text{E}(X)=100\times 0.03=3$ $\text{Var}(X)=100\times 0.03\times 0.97=2.91$	B1cao B1cao (2)
(d)	$\lambda=100\times 0.03=3$ $Y\sim \text{Po}(3)$ $\text{P}(Y>5) \quad =1-\text{P}(Y\le 5)$ $=1-0.9161$ $=0.0839$	B1 (use of) dM1 A1 (3) **[10]**
	Notes	
(a)	B1 independent B1 probability remains constant. One of these must have the context of disease. No context only one correct B0B0 If only one mark awarded give the first B1 SC if they are both correct without context award B1B0	
(b)	B1 for writing or using B(10,0.03) M1 for writing or using $(p)^2\,(1-p)^8\ \frac{10!}{2!8!}$ allow ${}^{10}\text{C}_2, \binom{10}{2}$ etc Allow P(X≤2) – P(X≤1) A1 awrt 0.0317	
(d)	B1 for using Poisson. Any mean. Common values which imply Poisson used are 0.9665 and 0.8153 dM1 for writing or using $1-\text{P}(X\le 5)$ - use of binomial gets M0. This is dependent on them being awarded the previous B mark. A1 awrt 0.0839 **SC: Use of Normal in (d)** Can get B0 M1 A0.- for M1 we must see $1-\text{P}(X\le 5)$ or $1-\text{P}(X\le 5.5)$ oe or get awrt 0.071	

Question Number	Scheme	Marks
2.	$H_0 : p = 0.2 \quad H_1 : p > 0.2$ Under H_0, $X \sim \text{Bin}(10,0.2)$ $P(X \geq 4) = 1 - P(X \leq 3) = 1 - 0.8791 = 0.1209$ OR $P(X \leq 4) = 0.9672$, $P(X \geq 5) = 0.0328$, CR $X \geq 5$ 0.1209>0.05. Insufficient evidence to reject H_0 so teacher's claim is supported.	B1 B1 M1 A1 M1A1ft **[6]**
	Notes	
	B1 for both H_0 and H_1 correct. Must use p or π (pi) B1 for writing or using Bin(10,0.2) M1 for finding or writing $1 - P(X \leq 3)$ or $P(X \leq 4) = 0.9672$ $P(X \geq 5) = 0.0328$ oe or a correct critical region A1 awrt 0.121 or CR $X \geq 5$ M1 need $p<0.5$ and: correct statement using their Probability and 0.05 if one tail test or correct statement using their Probability and 0.025 if two tail test (condone a comparison with 0.05 instead of 0.025 for a two tail test). Do not allow non-contextual conflicting statements eg "significant" and "accept H_0" A1ft correct contextual statement followed through from "their prob". Either a comment on whether the teacher's claim was correct or on whether the student was guessing the answers. NB if a correct contextual statement only is given for their probability then award M1 A1 If $p>0.5$ They may compare with 0.95 (one tail method) or 0.975 (two tail method) Probability is 0.8791.	

Question Number	Scheme	Marks
3. **(a)**	$\mathrm{E}(X)=\dfrac{3-1}{2}=1$	B1 cao **(1)**
(b)	$\mathrm{Var}(X)=\dfrac{(3+1)^2}{12}=\dfrac{4}{3}$ oe	M1A1 **(2)**
(c)	$\mathrm{E}(X^2)=\dfrac{4}{3}+1,\ =\dfrac{7}{3}$ oe	M1,A1 **(2)**
(d)	$\mathrm{P}(X<1.4)=0.6$	B1 cao **(1)**
(e)	$\mathrm{P}(X<0)=0.25$ Y is number of values less than 0 $Y\sim \mathrm{Bin}(40,0.25)$ $\mathrm{P}(Y\geq 10)=1-\mathrm{P}(Y\leq 9)$ $=1-0.4395=0.5605$	B1 M1A1 M1 A1 **(5)** **[11]**
	Notes	
(b)	M1 $\dfrac{(3-1)^2}{12}$ *or* $\dfrac{(3+1)^2}{12}$ *or* $\dfrac{(3--1)^2}{12}$ A1 awrt 1.33	
(c)	M1 "their(b)" + ["their (a)"]^2 or $\int_{-1}^{3}\dfrac{x^2}{4}\mathrm{d}x$ A1 awrt 2.33	
(e)	B1 For writing or using the probability of a negative = 0.25 M1 Writing or use of B(40, p) A1 Writing or use of B(40, 0.25) M1 Writing or using $1-\mathrm{P}(Y\leq 9)$ A1 awrt 0.561 or 0.560	

Question Number	Scheme	Marks
4.	H_0: $\lambda = 8$ or $\mu = 2$ H_1: $\lambda < 8$ or $\mu < 2$ Under H_0, $X \sim \text{Po}(8)$ $P(X \leq 3) = 0.0424$ CR $X \leq 3$ $0.0424 < 0.05$, Reject H_0. Richard's claim is supported.	B1 B1 M1 A1 M1A1ft **[6]**
	Notes	
	B1 for H_0 correct. Must use λ or μ and 8 or 2 B1 for H_1 correct. Must use λ or μ and 8 or 2 M1 for writing or using Po(8) – may be implied by correct CR A1 awrt 0.0424 or CR $X \leq 3$ M1 need $p<0.5$ and: correct statement using their Probability and 0.05 if one tail test or correct statement using their Probability and 0.025 if two tail test (condone a comparison with 0.05 instead of 0.025 for a two tail test). Do not allow non-contextual conflicting statements eg "significant" and "accept H_0" A1ft correct contextual statement followed through from "their prob". Either a comment on whether Richard's claim was correct or on whether the service has improved. NB if a correct contextual statement only is given for their probability then award M1 A1 $p>0.5$ They may compare with 0.95 (one tail method) or 0.975 (two tail method) Probability is 0.9576	

Question Number	Scheme	Marks
5. **(a)**	$m = -\frac{4}{0.5} = -8$ $\mathrm{f}(x) = 4 - 8x\ (*)$ $\mathrm{f}(x) = \begin{cases} -8x+4 & 0 \le x \le 0.5 \\ 0 & \textit{otherwise} \end{cases}$	M1 A1cso B1 B1 (4)
(b)	$\mathrm{F}(x) = \int_0^x (-8x+4)\mathrm{d}x$ $= \left[-4x^2+4x\right]_0^x$ $\mathrm{F}(x) = \begin{cases} 0 & x < 0 \\ -4x^2+4x & 0 \le x \le 0.5 \\ 1 & x > 0.5 \end{cases}$	M1 M1 A1 B1 (4)
(c)	$-4x^2+4x = 0.5$ $x = \frac{1}{4}(2-\sqrt{2}) = 0.146$	M1 M1A1 (3)
(d)	$x = 0$	B1 (1)
(e)	Positive Skew as mode<median	B1ft (1) **[13]**

Question Number	Scheme	Marks
	Notes	
(a)	M1 for $\pm\frac{4}{0.5}$ or attempt at gradient A1cso for proceeding to given expression with no incorrect working seen B1 for top line. Must have f(x) and { and more than one line. Condone use of <. B1 for 0 otherwise and no other parts.	
(b)	M1 attempting to integrate (at least one $x^n \rightarrow x^{n+1}$) (ignore limits) M1 correct limits used or +C and either F(0) = 0 or F(0.5) = 1, may be implied by seeing $4x - 4x^2$ A1 middle line. May write $4x - 4x^2$ B1 top and bottom line	
(c)	M1 Their F(x) = 0.5 M1 attempting to solve – either correct use of quadratic formula or correct completion of the square A1 awrt 0.146 or $\frac{2-\sqrt{2}}{4}$ o.e	
(d)	B1 for 0	
(e)	B1 ft their mode and median. Need direction and correct corresponding reason OR B1 positive skew from tail on right hand side in diagram	

Question Number	Scheme	Marks
6.		
(a)	X~Po(2.5)	M1A1 (2)
(b)	Cars arrive at the toll booth independently/randomly Cars arrive one at a time The rate of arrival at a toll booth remains constant at 2.5 per minute	 B1 B1 (2)
(c)(i)	$\mathrm{P}(X=0)=\mathrm{e}^{-2.5}=0.0821$	B1 (1)
(c)(ii)	$\mathrm{P}(X>3) \quad =1-\mathrm{P}(X\le 3)$ $=0.2424$	M1 A1 (2)
(d)	Use of Po(10) $1-0.0487=0.9513$ $m=15$	M1 M1 A1 cao (3)
(e)	$Y\sim \mathrm{N}(25,25)$ $\mathrm{P}(X<15)=\mathrm{P}(Y\le 14.5)$ $=\mathrm{P}\left(Z\le\dfrac{14.5-25}{5}\right)$ $=\mathrm{P}(Z\le -2.1)$ $=0.01786$	B1B1 M1 M1 A1 A1 (6) **[16]**

Question Number	Scheme	Marks
	Notes	
(a)	M1 Poisson A1 2.5	
(b)	Any two of the statements or equivalent. At least one must be in context. Need words that imply "cars arrive" or "rate of arrival." **SC** no context but 2 correct reasons B1B0 No context but 1 correct reason B0B0	
(c) (i)	B1 awrt 0.0821	
(ii)	M1 for writing or finding 1 - P($X \leq 3$)	
	A1 awrt 0.242	
(d)	M1 writing or using Po(10) M1 for 1- 0.0487 or 0.9513 seen or implied by correct value for m	
(e)	B1 use of normal B1 using or seeing mean and variance of 25 These first two marks may be given if the following are seen in the correct places in the standardisation formula : 25 and $\sqrt{25}$ or 5 M1 for attempting a continuity correction (14 ± 0.5) or (15 ± 0.5) M1 for standardising using their mean and their standard deviation and using [14.5, 14, 13.5, 15 or 15.5] accept $\pm$ z. A1 correct z value ± 2.1 **or** $\pm\frac{14.5-25}{5}$, A1 awrt 0.0179 NB use of calculator gets full marks if the answer is awrt 0.0179.	

Question Number	Scheme	Marks
7. **(a)**	$\int_0^9 k(81x - x^3)\mathrm{d}x = 1$ $k\left[\frac{81}{2}x^2 - \frac{1}{4}x^4\right]_0^9 = 1$ $k(\frac{6561}{2} - \frac{6561}{4}) = 1$ $k = \frac{4}{6561}$ **ag**	M1 M1 A1 cso (3)
(b)	$\mathrm{E}(X) = \int_0^9 kx^2(81 - x^2)\,\mathrm{d}x$ $= k\left[\frac{81}{3}x^3 - \frac{x^5}{5}\right]_0^9$ $= k(19683 - 11809.8)$ $= 4.8$	M1A1 dM1 A1 cao (4)
(c)	$\mathrm{P}(X > 5) = \int_5^9 k(81x - x^3)$ $= k\left[\frac{81}{2}x^2 - \frac{1}{4}x^4\right]_5^9$ $= k\left(\frac{6561}{4} - 856.25\right) =$ awrt 0.478 or $\frac{3136}{6561}$	M1 M1d A1 (3)
(d)	P(At least 2 queue for more than 5 mins) $= 3(1\text{-}0.478)(0.478)^2 + 0.478^3$ $= 0.467$	M1A1ft A1 (3) **[13]**

Question Number	Scheme	Marks
	Notes	
(a)	M1 putting integral = 1 ignore limits. =1 must appear at least once in the working. M1 attempting to integrate **at least one** part must have correct power of x (ignore limits) A1cso subst of at least 9. Allow 1/1640.25	
(b)	M1 attempt to use xf(x) and attempt to multiply out bracket and attempt at integration – must have x^3 and x^5 terms (ignore limits) A1 correct integration (ignore limits) dM1 substituting correct limits (need not explicitly see 0). Dependent on having been awarded the first M1.	
(c)	M1 attempting to integrate **at least one** part must have correct power of x (ignore limits) M1 dep on previous M being awarded, substituting correct limits [may use 1 – $\int_0^5 k(81x - x^3)$ with limits 0 and 5]	
(d)	M1 $3(1-p)p^2 + p^3$ o r $1-(1-p)^3 - 3(1-p)^2 p$ 3 not needed A1 for $\mathbf{3}(1-p)p^2 + p^3$ $1-(1-p)^3 - \mathbf{3}(1-p)^2 p$ where p is their solution to part (c) A1 awrt 0.467	

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