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Mark Scheme (Results)
January 2009

GCE

GCE Mathematics (6684/01)

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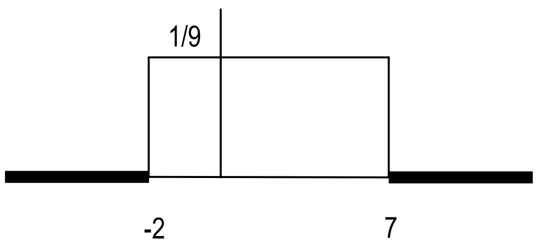
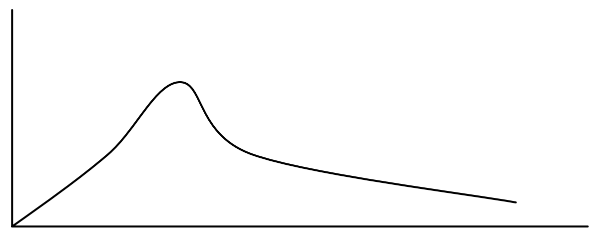
6684 Statistics S2
Mark Scheme

Question Number	Scheme	Marks
1	The random variable X is the number of daisies in a square.	
	Poisson(3)	B1
(a)	$1 - P(X \leq 2) = 1 - 0.4232$ $\quad 1 - e^{-3}(1 + 3 + \frac{3^2}{2!})$	M1
	$= 0.5768$	A1
		(3)
(b)	$P(X \leq 6) - P(X \leq 4) = 0.9665 - 0.8153$ $\quad e^{-3}\left(\frac{3^5}{5!} + \frac{3^6}{6!}\right)$	M1
	$= 0.1512$	A1
		(2)
(c)	$\mu = 3.69$	B1
	$\text{Var}(X) = \frac{1386}{80} - \left(\frac{295}{80}\right)^2$	M1
	$= 3.73/3.72/3.71$ $\quad$ accept $s^2 = 3.77$	A1
		(3)
(d)	For a Poisson model , Mean = Variance ; For these data $3.69 \approx 3.73$	
	$\Rightarrow$ Poisson model	B1
		(1)
(e)	$\frac{e^{-3.6875} 3.6875^4}{4!} = 0.193$ $\quad$ allow their mean or var	M1
	Awrt 0.193 or 0.194	A1 ft
		(2)

Question Number	Scheme	Marks
2 (a)	$\mathrm{f}(x)=\begin{cases}\frac{1}{9} & -2\le x\le 7\\ 0 & otherwise\end{cases}$	B1 B1 (2)
(b)		B1 B1 (2)
(c)	$\mathrm{E}(X)=\underline{2.5}$ Var $(X)=\frac{1}{12}(7+2)^2$ or $\underline{6.75}$ both	B1
	$\mathrm{E}(X^2)=\mathrm{Var}(X)+\mathrm{E}(X)^2$	M1
	$= 6.75 + 2.5^2$ $= 13$	A1 (3)
	alternative	
	$\int_{-2}^{7} x^2 f(x)dx = \left[\frac{x^3}{27}\right]_{-2}^{7}$ "$\int x^2 f(x)$" attempt to integrate and use limits of -2 and 7	B1 M1
	$= 13$	A1
(d)	$\mathrm{P}(-0.2 < X < 0.6) = \frac{1}{9}\times 0.8$	M1
	$= \frac{4}{45}$ or 0.0889 0r equiv awrt 0.089	A1 (2)

Question Number	Scheme	Marks
3 (a)	$X \sim \mathrm{B}(20, 0.3)$	M1
	$\mathrm{P}(X \le 2) = 0.0355$	
	$\mathrm{P}(X \ge 11) = 1 - 0.9829 = 0.0171$	
	Critical region is $(X \le 2) \cup (X \ge 11)$	A1 A1 (3)
(b)	Significance level = 0.0355 + 0.0171, = 0.0526 or 5.26%	M1 A1 (2)
(c)	Insufficient evidence to reject H_0 **Or** sufficient evidence to accept H_0 /not significant	B1 ft
	$x = 3$ (or the value) is not in the critical region or 0.1071> 0.025	B1 ft (2)
	Do not allow inconsistent comments	

Question Number	Scheme	Marks
4 (a)	$\int_0^{10} kt\mathrm{d}t = 1$ or Area of triangle = 1	M1
	$\left[\frac{kt^2}{2}\right]_0^{10} = 1$ or 10 x0.5 x 10k =1 or linear equation in k	M1
	$50k = 1$	
	$k = \frac{1}{50}$ cso	A1
		(3)
(b)	$\int_6^{10} ktdt = \left[\frac{\text{kt}^2}{2}\right]_6^{10}$	M1
	$= \frac{16}{25}$	A1
		(2)
(c)	$\text{E}(T) = \int_0^{10} kt^2 dt = \left[\frac{\text{kt}^3}{3}\right]_0^{10}$	M1
	$= 6\frac{2}{3}$	A1
	$\text{Var (T)} = \int_0^{10} kt^3 dt - \left(6\frac{2}{3}\right)^2 = \left[\frac{kt^4}{4}\right]_0^{10}; -\left(6\frac{2}{3}\right)^2$	M1;M1dep
	$= 50 - \left(6\frac{2}{3}\right)^2$	
	$= 5\frac{5}{9}$	A1
		(5)
(d)	10	B1
		(1)
(e)		B1
		(1)

Question Number	Scheme	Marks
5 (a)	X represents the number of defective components.	
	P (X = 1) $= (0.99)^9 (0.01) \times 10$ =0.0914	M1A1
		(2)
(b)	P ($X \geq 2$) = 1 – P($X \leq 1$) = 1 – $(p)^{10}$ – (a) = 0.0043	M1 A1ft A1
		(3)
(c)	$X \sim$ Po(2.5)	B1B1
	P(1 $\leq X \leq$ 4) = P($X \leq$ 4) - P(X = 0)	M1
	= 0.8912 – 0.0821	
	= 0.809	A1
		(4)
	Normal distribution used. B1for mean only	
	Special case for parts a and b If they use 0.1 do not treat as misread as it makes it easier. (a) M1 A0 if they have 0.3874 (b) M1 A1ft A0 they will get 0.2639 (c) Could get B1 B0 M1 A0	
	For any other values of p which are in the table do not use misread. Check using the tables. They could get (a) M1 A0 (b) M1 A1ft A0 (c) B1 B0 M1 A0	

Question Number	Scheme	Marks
6 (a)(i)	$H_0 : \lambda = 7$ $\quad$ $H_1 : \lambda > 7$	B1
	X = number of visits. $X \sim Po(7)$	B1
	$P(X \geq 10) = 1 - P(X \leq 9)$ $\quad$ $1 - P(X \leq 10) = 0.0985$	M1
	$= 0.1695$ $\quad$ $1 - P(X \leq 9) = 0.1695$ CR $X \geq 11$	A1
	$0.1695 > 0.10$, $\quad$ CR $X \geq 11$ Not significant or it is not in the critical region or do not reject H_0	M1
	The rate of visits on a Saturday is not greater/ is unchanged	A1 no ft
(ii)	$X = 11$	B1 (7)
(b)	(The visits occur) randomly/ independently or singly or constant rate	B1 (1)
(c)	[$H_0 : \lambda = 7$ $\quad$ $H_1 : \lambda > 7$ $\quad$ (or $H_0 : \lambda = 14$ $\quad$ $H_1 : \lambda > 14$)]	
	$X \sim$N;(14,14)	B1;B1
	$P(X \geq 20) = P\left(z \geq \frac{19.5 - 14}{\sqrt{14}}\right)$ $\quad$ +/- 0.5, stand	M1 M1
	$= P(z \geq 1.47)$ $= 0.0708$ $\quad$ or $z = 1.2816$	A1dep both M
	$0.0708 < 0.10$ therefore significant. The rate of visits is greater on a Saturday	A1dep 2nd M (6)

Question Number	Scheme	Marks
7 (a)	$F(x_0) = \int_1^x -\frac{2}{9}x + \frac{8}{9}\,dx = \left[-\frac{1}{9}x^2 + \frac{8}{9}x\right]_1^x$	M1A1
	$= \left[-\frac{1}{9}x^2 + \frac{8}{9}x\right] - \left[-\frac{1}{9} + \frac{8}{9}\right]$	
	$= -\frac{1}{9}x^2 + \frac{8}{9}x - \frac{7}{9}$	A1
		(3)
(b)	$F(x) = \begin{cases} 0 & x < 1 \\ -\frac{1}{9}x^2 + \frac{8}{9}x - \frac{7}{9} & 1 \le x \le 4 \\ 1 & x > 4 \end{cases}$	B1B1√
		(2)
(c)	$F(x) = 0.75$; or $F(2.5) = -\frac{1}{9} \times 2.5^2 + \frac{8}{9} \times 2.5 - \frac{7}{9}$	M1;
	$-\frac{1}{9}x^2 + \frac{8}{9}x - \frac{7}{9} = 0.75$	
	$4x^2 - 32^x + 55 = 0$	
	$-x^2 + 8x - 13.75 = 0$	
	$x = 2.5$ $= 0.75$ cso	A1
	and $F(x) = 0.25$	
	$-\frac{1}{9}x^2 + \frac{8}{9}x - \frac{7}{9} = 0.25$	M1
	$-x^2 + 8x - 7 = 2.25$	
	$-x^2 + 8x - 9.25 = 0$ quadratic 3 terms =0	M1 dep
	$x = \dfrac{-8 \pm \sqrt{8^2 - 4 \times -1 \times -9.25}}{2 \times -1}$	M1 dep
		A1
	$x = 1.40$	
		(6)
(d)	$Q_3 - Q_2 > Q_2 - Q_1$ Or mode = 1 and mode < median Or mean = 2 and median < mode Sketch of pdf here or be referred to if in a different part of the question Box plot with Q_1, Q_2, Q_3 values marked on	M1
	Positive skew	A1
		(2)