GCE Examinations

Advanced Subsidiary / Advanced Level

Statistics
Module S2

Paper C

MARKING GUIDE

This guide is intended to be as helpful as possible to teachers by providing concise solutions and indicating how marks should be awarded. There are obviously alternative methods that would also gain full marks.

Method marks (M) are awarded for knowing and using a method.

Accuracy marks (A) can only be awarded when a correct method has been used.

(B) marks are independent of method marks.

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S2 Paper C – Marking Guide

1.	*(a)*	(i)	e.g. all individuals or items of relevance	B1	
		(ii)	e.g. a selection of individuals or items from a population	B1	
	(b)	(i)	census – e.g. need to know requirements of all for catering	B2	
		(ii)	sample – e.g. testing is destructive, none left after census	B2	**(6)**

2.	*(a)*	let X = no. of complaints per day $\therefore X \sim \text{Po}(6)$	M1	
		$\text{P}(X = 3) = 0.1512 - 0.0620 = 0.0892$	M1 A1	
	(b)	$\text{P}(X \geq 10) = 1 - \text{P}(X \leq 9) = 1 - 0.9161 = 0.0839$	M1 A1	
	(c)	let Y = no. of days with 10 or more complaints $\therefore Y \sim \text{B}(6, 0.0839)$	M1	
		$\text{P}(Y \leq 1) = (0.9161)^6 + 6(0.0839)(0.9161)^5$	M1 A1	
		$= 0.916$ (3sf)	A1	**(9)**

3.	*(a)*	let X = no. out of 8 who take out policies $\therefore X \sim \text{B}(8, 0.3)$	M1	
		$\text{P}(X = 2) = 0.5518 - 0.2553 = 0.2965$	M1 A1	
	(b)	$\text{P}(X > 4) = 1 - \text{P}(X \leq 4) = 1 - 0.9420 = 0.0580$	M1 A1	
	(c)	let Y = no. out of 150 who take out policies $\therefore Y \sim \text{B}(150, 0.3)$	M1	
		N approx. $S \sim \text{N}(45, 31.5)$	M1	
		$\text{P}(Y > 50) \approx \text{P}(S > 50.5)$	M1	
		$= \text{P}(Z > \frac{50.5 - 45}{\sqrt{31.5}}) = \text{P}(Z > 0.98)$	A1	
		$= 1 - 0.8365 = 0.1635$	A1	**(10)**

4.	*(a)*	let X = no. of tries per match $\therefore X \sim \text{Po}(0.4)$	M1	
		$\text{P}(X \geq 2) = 1 - \text{P}(X \leq 1)$	M1	
		$= 1 - e^{-0.4}(1 + 0.4)$	M1 A1	
		$= 1 - 0.9384 = 0.0616$ (3sf)	A1	
	(b)	let Y = no. of tries per 5 matches $\therefore Y \sim \text{Po}(2)$	M1	
		$H_0 : \lambda = 2 \quad H_1 : \lambda > 2$	B1	
		$\text{P}(Y \geq 6) = 1 - \text{P}(Y \leq 5) = 1 - 0.9834 = 0.0166$	M1 A1	
		less than 5% $\therefore$ significant, evidence of increase	A1	**(10)**

5.	*(a)*	$P(X < 2) = F(2) = \frac{1}{432} \times 4 \times (4 - 32 + 72) = \frac{11}{27}$	M1 A1	
	(b)	$F(x) = \frac{1}{432}(x^4 - 16x^3 + 72x^2)$	M1	
		$f(x) = F'(x) = \frac{1}{432}(4x^3 - 48x^2 + 144x)$	M1 A1	
		$\therefore f(x) = \begin{cases} \frac{1}{108}(x^3 - 12x^2 + 36x), & 0 \le x \le 6, \\ 0, & \text{otherwise.} \end{cases}$ [or $\frac{1}{108}x(x-6)^2$]	A1	
	(c)	$f'(x) = \frac{1}{108}(3x^2 - 24x + 36)$	M1	
		for S.P. = 0 giving $x^2 - 8x + 12 = 0$	M1 A1	
		$\therefore (x - 6)(x - 2) = 0$ so $x = 2$ or 6	M1	
		some justification, e.g. +ve cubic / $f(x) = 0$ at 0 and 6 $\therefore$ mode = 2	M1 A1	
	(d)	median higher as $P(X < 2)$ is less than $\frac{1}{2}$	B1	**(13)**
6.	*(a)*	fixed no. of eggs, eggs either broken or not, prob. of each egg being broken is same (assuming no accident breaking group together)	B3	
	(b)	let X = no. of eggs broken in delivery $\therefore X \sim B(120, 0.008)$	M1	
		$P(X \le 1) = (0.992)^{120} + 120(0.008)(0.992)^{119}$	M1 A1	
		$= 0.7505$ (4sf)	A1	
	(c)	n large, p small	B1	
	(d)	$X \approx\sim Po(0.96)$	M1	
		$P(X \le 1) \approx e^{-0.96}(1 + 0.96)$	M1 A1	
		$= 0.7505$ (4sf)	A1	
		same value to 4sf, very good approx. for these parameters	B1	**(13)**
7.	*(a)*	6.5	A1	
	(b)	$2.4 \times \frac{1}{9} = \frac{4}{15}$ or 0.2667 (4sf)	M1 A1	
	(c)	$= P(3 < X < 7) = 4 \times \frac{1}{9} = \frac{4}{9}$ or 0.4444 (4sf)	M1 A1	
	(d)	$f(y) = \frac{1}{b-a}$	B1	
		$E(Y^2) = \int_a^b \frac{1}{b-a} y^2 \, dy$	M1	
		$= \frac{1}{b-a}[\frac{1}{3}y^3]_a^b$	A1	
		$= \frac{b^3 - a^3}{3(b-a)}$	M1	
		$= \frac{1}{3}(b^2 + ab + a^2)$	A1	
	(e)	$Var(Y) = E(Y^2) - [E(Y)]^2$	M1	
		$= \frac{1}{3}(b^2 + ab + a^2) - \frac{1}{4}(a^2 + 2ab + b^2)$	M1	
		$= \frac{1}{12}(4b^2 + 4ab + 4a^2 - 3a^2 - 6ab - 3b^2)$	M1	
		$= \frac{1}{12}(b^2 - 2ab + a^2) = \frac{1}{12}(b - a)^2$	A1	**(14)**
			Total	**(75)**

Performance Record – S2 Paper C

Question no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Total
Topic(s)	sampling	Poisson, binomial	binomial, N approx.	Poisson, hyp. test	c.d.f., p.d.f., mode, median	binomial, Po appr. to binomial	rect. dist., deriving variance	
Marks	6	9	10	10	13	13	14	75
Student								