GCE Examinations

Advanced Subsidiary / Advanced Level

Statistics
Module S2

Paper B

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.

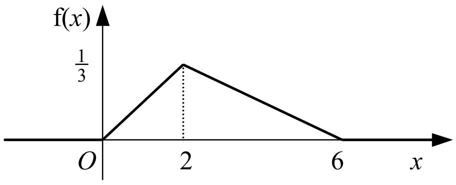
(B) marks are independent of method marks.

Written by Shaun Armstrong & Chris Huffer

S2 Paper B – Marking Guide

1.	*(a)*	e.g. list of all the sampling units	B1	
	(b)	(i) frame – list of cars serviced at garage	B1	
		units – individual cars	B1	
		(ii) frame – list of people involved in trial	B1	
		units – individual people	B1	**(5)**
2.	*(a)*	Poisson (with $\lambda = 4.2$)	B1	
	(b)	(i) e.g. may be more or less species that like nuts	B1	
		(ii) e.g. will last longer so may get more species visiting	B1	
	(c)	let X = no. of species that visit $\therefore X \sim \text{Po}(4.2)$		
		$\text{P}(X = 6) = \frac{e^{-4.2} \times 4.2^6}{6!} = 0.1143$ (4sf)	M1 A1	
	(d)	$\text{P}(X > 2) = 1 - \text{P}(X \le 2)$	M1	
		$= 1 - e^{-4.2}(1 + 4.2 + \frac{4.2^2}{2})$	M1 A1	
		$= 1 - 0.2102 = 0.7898$ (4sf)	A1	**(9)**
3.	*(a)*	$1.6 \times \frac{1}{20} = 0.08$	M1 A1	
	(b)	mean = 10	A1	
		variance $= \frac{1}{12}(20 - 0)^2 = \frac{100}{3}$	M1 A1	
	(c)	$= \text{P}(X \text{ in middle 4 cm}) \times \text{P}(Y \text{ in middle 4 cm})$	M1	
		$= (4 \times \frac{1}{20}) \times (4 \times \frac{1}{16})$	M1 A1	
		$= \frac{1}{5} \times \frac{1}{4} = \frac{1}{20}$	A1	
	(d)	$= 1 - [\text{P}(X \text{ in middle 16 cm}) \times \text{P}(Y \text{ in middle 12 cm})]$	M1 A1	
		$= 1 - [(16 \times \frac{1}{20}) \times (12 \times \frac{1}{16})]$	M1	
		$= 1 - (\frac{4}{5} \times \frac{3}{4}) = 1 - \frac{3}{5} = \frac{2}{5}$	A1	**(13)**
4.	*(a)*	let X = no. of failures per hour $\therefore X \sim \text{Po}(3)$		
		$\text{P}(X = 0) = 0.0498$	A1	
	(b)	let Y = no. of failures per half-hour $\therefore Y \sim \text{Po}(1.5)$	M1	
		$\text{P}(Y > 4) = 1 - \text{P}(Y \le 4) = 1 - 0.9814 = 0.0186$	M1 A1	
	(c)	let F = no. of failures per 24 hrs $\therefore F \sim \text{Po}(72)$	M1	
		N approx. $G \sim \text{N}(72, 72)$	M1	
		$\text{P}(F < 60) \approx \text{P}(G < 59.5)$	M1	
		$= \text{P}(Z < \frac{59.5 - 72}{\sqrt{72}}) = \text{P}(Z < {}^{-}1.47)$	A1	
		$= 1 - 0.9292 = 0.0708$	A1	
	(d)	$\text{P}(F = 72) \approx \text{P}(71.5 < G < 72.5)$	M1	
		$= \text{P}(Z < \frac{72.5 - 72}{\sqrt{72}}) - \text{P}(Z < \frac{71.5 - 72}{\sqrt{72}})$	M1	
		$= \text{P}(Z < 0.06) - \text{P}(Z < {}^{-}0.06)$	A1	
		$= 0.5239 - 0.4761 = 0.0478$	A1	**(13)**

5.	*(a)*	let X = no. of dice showing 6 $\therefore X \sim \text{B}(6, \frac{1}{6})$	M1	
		$\text{P}(X = 0) = (\frac{5}{6})^6 = 0.3349$ (4sf)	M1 A1	
	(b)	$\text{P}(X > 1) = 1 - \text{P}(X \leq 1)$	M1	
		$= 1 - [(\frac{5}{6})^6 + 6(\frac{1}{6})(\frac{5}{6})^5]$	M1 A1	
		$= 1 - 0.7368 = 0.2632$ (4sf)	A1	
	(c)	let Y = no. of dice showing odd $\therefore Y \sim \text{B}(6, \frac{1}{2})$	M1	
		$\text{P}(Y = 3) = 0.6563 - 0.3438 = 0.3125$	M1 A1	
	(d)	let S = no. of times it shows a 6 $\therefore S \sim \text{B}(8, \frac{1}{6})$	M1	
		$\text{H}_0 : p = \frac{1}{6} \quad \text{H}_1 : p > \frac{1}{6}$	B1	
		$\text{P}(S \geq 3) = 1 - \text{P}(S \leq 2)$	M1	
		$= 1 - [(\frac{5}{6})^8 + 8(\frac{1}{6})(\frac{5}{6})^7 + \frac{8 \times 7}{2}(\frac{1}{6})^2(\frac{5}{6})^6]$	M1 A1	
		$= 1 - 0.8652 = 0.1348$	A1	
		more than 5% $\therefore$ not significant, insufficient evidence of bias	A1	**(17)**

6.	*(a)*		B4	
	(b)	2	A1	
	(c)	0 to 2: $\text{F}(t) = \int_0^t \frac{1}{6}x \; \text{d}x$	M1	
		$= [\frac{1}{12}x^2]_0^t = \frac{1}{12}t^2$	M1 A1	
		2 to 6: $\text{F}(t) = \frac{1}{2} \times 2 \times \frac{1}{3} + \int_2^t \frac{1}{12}(6 - x) \; \text{d}x$	M1	
		$= \frac{1}{3} + \frac{1}{12}[6x - \frac{1}{2}x^2]_2^t$	M1 A1	
		$= \frac{1}{3} + \frac{1}{12}[(6t - \frac{1}{2}t^2) - (12 - 2)]$	M1	
		$= \frac{1}{24}(12t - t^2 - 12)$	A1	
		$\therefore \text{F}(x) = \begin{cases} 0, & x < 0, \\ \frac{1}{12}x^2 & 0 \leq x \leq 2, \\ \frac{1}{24}(12x - x^2 - 12) & 2 \leq x \leq 6, \\ 1, & x > 6. \end{cases}$	A1	
	(d)	$\frac{1}{24}(12m - m^2 - 12) = \frac{1}{2}$	M1	
		$m^2 - 12m + 24 = 0$	A1	
		$m = 2.536$ or 9.464; $2 \leq m \leq 6$ $\therefore$ median $= 2.536$ (4sf)	M1 A1	**(18)**

Total **(75)**

Performance Record – S2 Paper B

Question no.	**1**	**2**	**3**	**4**	**5**	**6**	Total
Topic(s)	sampling	Poisson	rect. dist.	Poisson, N approx.	binomial, hyp. test	p.d.f., mode, c.d.f., median	
Marks	5	9	13	13	17	18	75
Student							