EDEXCEL

190 High Holborn London WC1V 7BH

January 2005

Advanced Subsidiary/Advanced Level

General Certificate of Education

FINAL
[signature] 28/01/05

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

Question Number	Scheme		Marks	
1.	(a) $P(R=5) = P(R \le 5) - P(R \le 4) = 0.7216 - 0.5155$	Can be implied	M1	
	$= 0.2061$	AWRT 0.2061	A1	(2)
	(OR: ${}^{15}C_5(0.3)^5(0.7)^{10} = 0.206130....$)			
	(b) $P(S=5) = 0.2414 - 0.1321 = 0.1093$	Accept 0.1093 or 0.1094 AWRT AWRT	B1	(1)
	(OR: $\frac{7.5^5 e^{-7.5}}{5!} = 0.10937459....$)			
	(c) $P(T=5) = 0$	cao	B1	(1)
2.	(a) (i) A collection of individuals or items		B1	
	(ii) A list of all sampling units in the population		B1	(2)
	(b) Not always possible to keep this list up to date		B1	(1)
	(c) (i) eg:- Pupils in year 12 – small easily listed ~~sample~~ population		B1	
	Population known & easily accessed		B1	
	(ii) Students in a University – Large not easily listed population		B1	
	Population known but too time consuming/expensive to interview all of them.		B1	(4)
	(c) SR (i) Definition of census by example		B1	
	(ii) " " sample " "		B1	

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3.	(a) Continuous uniform/Rectangular	B1
	$f(x) = \begin{cases} 1/l, & 0 \le x \le l \\ 0 & \text{otherwise} \end{cases}$	B1 B1 (3)
	(b) $P(X < \frac{1}{3}l) = \frac{1}{l} \times \frac{l}{3} = \frac{1}{3}$ Their $\frac{1}{l} \times \frac{l}{3}$	M1A1 (2)
	(c) $E(X) = \frac{1}{2}l$	B1 (1)
	(d) $P(\text{Both} < \frac{1}{3}l) = \left(\frac{1}{3}\right)^2 = \frac{1}{9}$ $(b)^2$	M1 A1√ (2)
4.	(a) Probability of success/failure is constant Trials are independent	B1 B1 (2)
	(b) Let p represent proportion of students who can distinguish between brands	
	$H_0: p = 0.1$; $H_1: p > 0.1$ (both)	B1
	$\alpha = 0.01$; CR: $z > 2.3263$ 2.3263	B1
	$np = 25$; $npq = 22.5$ both Can be implied	B1
	$z = \frac{39.5 - 25}{\sqrt{22.5}} = 3.0568....$ Standardisation with ± 0.5 & their $\sqrt{npq}$	M1
	AWRT 3.06	A1
	Reject H_0: claim cannot be accepted Based on clear evidence from z opp	A1√ (6)
	(c) eg:- np, nq both > 5 — true so acceptable p close to 0.5 — not true, assumption not met success/failure not clear cut necessarily independence — one student influences another	B1 B1 (2)

(b) Alter $z = 3.06 \Rightarrow p = 0.9989 > 0.99$ or $p = 0.0011 < 0.01$ } B1 equiv to 2.3263

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5.	Let X represent the number of defective articles		
	$\therefore X \sim B(10, 0.032)$		
	(a) $P(X=2) = {}^{10}C_2 (0.032)^2(1-0.032)^8$ (45)	Use of ${}^nC_r p^r q^{n-r}$	M1
		All correct	A1
	$= 0.0355274....$	AWRT 0.0355	A1 (3)
	(b) Large n, small p $\Rightarrow$ Poisson approximation	Seen or implied	B1
	with $\lambda = 100 \times 0.032 = 3.2$		
	$P(X<4) = P(X \le 3) = P(0) + P(1) + P(2) + P(3)$	$P(X \le 3)$ stated or implied	M1
	NB Normal Approx $\Rightarrow$ 0/4 $= e^{-3.2}\left\{1 + 3.2 + \frac{(3.2)^2}{2} + \frac{(3.2)^3}{6}\right\}$	All correct	A1
	$= 0.602519....$	AWRT 0.603	A1 (4)
	(c) np & nq both >5 $\Rightarrow$ Normal approximation	N approx	M1
	with $np = 32$ and $npq = 30.976$	both	A1
	$P(X>42) \approx P(Y>42.5)$ where $Y \sim N(32, 30.976)$	Standardise their np, $\sqrt{npq}$	M1
	$= P\left(Z > \frac{42.5-32}{\sqrt{30.976}}\right)$	All correct	A1
	$= P(Z > 1.8865....)$	AWRT 1.89	A1
	$= 0.0294$	0.0294 – 0.0297	A1 (6)

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6.	Let X represent number of accidents/month $\therefore X \sim Po(3)$	B1
	(a) $P(X>4) = 1 - P(X \leq 4)$; $= 1 - 0.8513 = \underline{0.1847}$	M1; A1 (3)
	(b) Let Y represent number of accidents in 3 months $\therefore Y \sim Po(3 \times 3 = 9)$ Can be implied	B1
	$P(Y>4) = 1 - 0.0550 = \underline{0.9450}$	B1 (2)
	(c) $H_0: \lambda = 3$; $H_1: \lambda < 3$ both (2 tailed; allow B0 B1 M1 (0.025) A0)	B1
	$\alpha = 0.05$	
	$P(X \leq 1 \mid \lambda = 3) = 0.1991$; > 0.05	B1; M1
	$\therefore$ Insufficient evidence to support the claim that the mean number of accidents has been reduced.	A1√ (4)
	(NB: CR: $X \leq 0$; $X = 1$ not in CR; same conclusion $\Rightarrow$ B1, M1, A1)	
	(d) $H_0: \lambda = 24 \times 3 = 72$; $H_1: \lambda < 72$ Can be implied $\lambda = 72$	B1
	both H_0 & H_1	B1
	$\alpha = 0.05 \Rightarrow$ CR: $z < -1.6449$ -1.6449	B1
	Using Normal approximation with $\mu = \sigma^2 = 72$ Can be implied	B1
	$z = \dfrac{55.5 - 72}{\sqrt{72}} = -1.94454\ldots$ Stand^n with ± 0.5, μ & σ	M1
	AWRT -1.945	A1
	Since $-1.944\ldots$ is in the CR, H_0 is rejected. There is evidence that the restriction has reduced the number of accidents. Context & clear evidence	A1√ (7)
	Alt (d) $p = 0.0262 < 0.05$ AWRT 0.026 B1 equiv to -1.6449	

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7.	(a) $k\int_1^4(-x^2+5x-4)\,dx=1$	Using $\int f(x)\,dx=1$	M1
	$\therefore k\left[-\frac{x^3}{3}+\frac{5x^2}{2}-4x\right]_1^4=1$	All correct integ^n with limits	A1
	* $\Rightarrow k=\frac{2}{9}$ *	c.s.o	A1 (3)
	(b) $E(X)=\int_1^4 \frac{2}{9}(-x^3+5x^2-4x)\,dx$	Using $\int xf(x)\,dx$	M1
	$=\frac{2}{9}\left[-\frac{x^4}{4}+\frac{5x^3}{3}-\frac{4x^2}{2}\right]_1^4$	Correct integ^n with limits	A1
	$=\frac{5}{2}$	cao	A1 (3)
	(c) $\frac{d}{dx}f(x)=\frac{2}{9}(-2x+5)=0$; $\Rightarrow$ Mode $=\frac{5}{2}$ (SC: $\frac{5}{2}$ only; no working B1)	Diff^n of $f(x)$ & $=0$	M1; A1 (2)
	(d) $F(x)=\int_1^{x_0}\frac{2}{9}(-x^2+5x-4)\,dx$	Using $\int f(x)\,dx$	M1
	$=\left[\frac{2}{9}\left(-\frac{x^3}{3}+\frac{5x^2}{2}-4x\right)\right]_1^{x_0}$	Integ^n with limits 1 & symbol	A1
	$=\frac{2}{9}\left\{-\frac{x_0^3}{3}+\frac{5x_0^2}{2}-4x_0+\frac{11}{6}\right\}$	aef	A1
	$\therefore F(x)=\begin{cases}0 & x<1\\ \frac{2}{9}\left\{-\frac{x^3}{3}+\frac{5x^2}{2}-4x+\frac{11}{6}\right\} & 1\le x\le 4\\ 1 & x>4\end{cases}$	$x<1$; $x>4$ $1\le x\le 4$	B1 B1 (5)
	(e) $P(X\le 2.5)=F(2.5)=0.5$	$F(2.5)$ or integral etc	M1 A1 (2)
	(f) Median $=2.5$; Distribution is symmetrical		B1; B1 (2) cao cao