# EDEXCEL

190 High Holborn London WC1V 7BH

FINAL
Mr Keywords
28/01/05

**January 2005**

**Advanced Subsidiary/Advanced Level**

General Certificate of Education

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

| Question Number | Scheme | Marks |
|---|---|---|
| 1. | (a) $P(R=5) = P(R\leq 5) - P(R\leq 4) = 0.7216 - 0.5155$ Can be implied M1<br>$= 0.2061$ AWRT 0.2061 A1 (2)<br>(OR: ${}^{15}C_5(0.3)^5(0.7)^{10} = 0.206130\ldots$)<br>(b) $P(S=5) = 0.2414 - 0.1321 = 0.1093$ Accept 0.1093 or 0.1094 AWRT AWRT B1 (1)<br>(OR: $\frac{7.5^5 e^{-7.5}}{5!} = 0.109371459\ldots$)<br>(c) $P(T=5) = 0$ cao B1 (1) | |
| 2. | (a) (i) A collection of individuals or items B1<br>(ii) A list of all sampling units in the population B1 (2)<br>(b) Not always possible to keep this list up to date B1 (1)<br>(c) (i) eg:- Pupils in year 12 – small easily listed ~~sample~~ population B1<br>Population known & easily accessed B1<br>(ii) Students in a University – Large not easily listed population B1<br>Population known but too time consuming/expensive to interview all of them. B1 (4) | |
| | (c) SR (i) Definition of census by example B1<br>(ii) " " sample " " B1 | |

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| 3. | (a) Continuous uniform/Rectangular | B1 |
| | $f(x) = \begin{cases} \frac{1}{l}, & 0 \le x \le l \\ 0 & \text{otherwise} \end{cases}$ | 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) $P(\text{Both} < \frac{1}{3}l) = (\frac{1}{3})^2 = \frac{1}{9}$ $(b)^2$ | M1 |
| | | A1√(2) |
| 4. | (a) Probability of success/failure is constant | B1 |
| | Trials are independent | 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 |
| | $z = \frac{39.5 - 25}{\sqrt{22.5}} = 3.0568\ldots$ Standardisation with $\pm 0.5$ & their $\sqrt{npq}$ | M1 |
| | AWRT 3.06 | A1 |
| | Reject $H_0$: claim cannot be accepted Based on clear evidence from $z$ or $p$ | A1√ (6) |
| | (c) eg:- $np$, $nq$ both $> 5$ — true so acceptable | B1 (2) |
| | $p$ close to 0.5 — not true, assumption not met | B1 |
| | success/failure not clear cut necessarily independence — one student influences another | |

(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<br>$\therefore X \sim B(10, 0.032)$ | |
| (a) | $P(X=2) = {}^{10}C_2 (0.032)^2 (1-0.032)^8$ | Use of ${}^nC_r p^r q^{n-r}$ M1 |
| | | All correct A1 |
| | $= 0.0355274\ldots$ | AWRT 0.0355 A1 (3) |
| (b) | Large $n$, small $p \Rightarrow$ Poisson approximation with $\lambda = 100 \times 0.032 = 3.2$ | Seen or implied B1 |
| | $P(X<4) = P(X \leq 3) = P(0) + P(1) + P(2) + P(3)$ | $P(X \leq 3)$ 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 |
| | $= 0.602519\ldots$ | AWRT 0.603 A1 (4) |
| (c) | $np$ & $nq$ both $>5 \Rightarrow$ Normal approximation with $np = 32$ and $npq = 30.976$ | N approx M1<br>both A1 |
| | $P(X > 42) \approx P(Y > 42.5)$ where $Y \sim N(32, 30.976)$ | Standardising using their $np$, $\sqrt{npq}$ M1 |
| | $= P\left(Z > \frac{42.5 - 32}{\sqrt{30.976}}\right)$ | All correct A1 |
| | $= P(Z > 1.8865\ldots)$ | 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) $P(X>4) = 1 - P(X \leq 4) = 1 - 0.8513 = \underline{0.1487}$ | 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) $H_0: \lambda = 3$; $H_1: \lambda < 3$ (2 tailed; allow B0 B1 M1 (0.025) A0) both | 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. (NB: CR: $X \leq 0$; $X=1$ not in CR; same conclusion $\Rightarrow$ B1, M1, A1) | A1√ (4) |
| | (d) $H_0: \lambda = 24\times 3 = 72$; $H_1: \lambda < 72$ Can be implied $\lambda = 72$ | B1 |
| | $\alpha = 0.05 \Rightarrow$ CR: $z < -1.6449$ both Hs with | B1 |
| | $-1.6449$ | 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 $\pm 0.5$, $\mu$ & $\sigma$ | 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) |
| | Alter (d) $p = 0.0262 < 0.05$ AWRT 0.026 B1 equiv to $-1.6449$ | |

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| 7. | (a) $k\int_1^4(-x^2+5x-4)\,dx=1$ | Use of $\int f(x)dx=1$ M1 |
| | $\therefore k\left[-\frac{x^3}{3}+\frac{5x^2}{2}-4x\right]_1^4=1$ | All correct integ$^n$ with limits A1 |
| | $* \Rightarrow \underline{k=2/9}$ $*$ | c.s.o A1 (3) |
| | (b) $E(X)=\int_1^4 2/9(-x^3+5x^2-4x)\,dx$ | Use of $\int xf(x)dx$ M1 |
| | $=2/9\left[-\frac{x^4}{4}+\frac{5x^3}{3}-\frac{4x^2}{2}\right]_1^4$ | Correct integ$^n$ with limits A1 |
| | $=\underline{5/2}$ | cao A1 (3) |
| | (c) $\frac{d}{dx}f(x)=2/9(-2x+5)=0 \Rightarrow$ Mode $=5/2$ | Diff$^n$ of $f(x)$ $=0$ M1; A1 (2) |
| | Se: 5/2 only, no working B1 | |
| | (d) $F(x)=\int_1^{x_0}2/9(-x^2+5x-4)\,dx$ | Use of $\int f(x)dx$ M1 |
| | $=\left[2/9(-\frac{x^3}{3}+\frac{5x^2}{2}-4x\right]_1^{x_0}$ | Integ$^n$ with limits 1 & sym. A1 |
| | $=2/9\left\{-\frac{x_0^3}{3}+\frac{5x_0^2}{2}-4x_0+\frac{11}{6}\right\}$ | a/f A1 |
| | $\therefore F(x)=\begin{cases}0 & x<1 \\ 2/9\left\{-\frac{x^3}{3}+\frac{5x^2}{2}-4x+\frac{11}{6}\right\} & 1\le x\le 4 \\ 1 & x>4\end{cases}$ | $x<1$; $x>4$ B1; $1\le x\le 4$ 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 |