Edexcel GCE
Statistics S2
Gold Level G4
(Mark Scheme)

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Question Number		Scheme	Marks
1.	(a)	A population is collection of all items	B1 (1)
	(b)	(A random variable) that is a function of the sample which contains no unknown quantities/parameters.	B1 (1)
	(c)	The voters in the town	B1
		Percentage/proportion voting for Dr Smith	B1 (2)
	(d)	Probability Distribution of those voting for Dr Smith from all possible samples (of size 100)	B1 (1)
			[5]

2.	(a)	(5,5,5) or (1,5,5) or (2,5,5)	B1
		(5,5,5) (5,5,1) (5,1,5) (1,5,5) (5,5,2) (5,2,5) (2,5,5) or (5,5,5) **and** (5,5,1) ($\times 3$) **and** (5,5,2) ($\times 3$)	B1 (2)
	(b)	(5,5,5) $\left(\frac{3}{10}\right)^3 = \frac{27}{1000} = 0.027$	B1
		(5,5,1) $3\times\frac{1}{2}\times\left(\frac{3}{10}\right)^2 = \frac{135}{1000}$ *or* $\frac{27}{200} = 0.135$	M1
		(5,5,2) $3\times\frac{1}{5}\times\left(\frac{3}{10}\right)^2 = \frac{54}{1000} = \frac{27}{500} = 0.054$	
		P(M = 5) = $\left(\frac{3}{10}\right)^3 + 3\times\frac{1}{2}\times\left(\frac{3}{10}\right)^2 + 3\times\frac{1}{5}\times\left(\frac{3}{10}\right)^2 = \frac{27}{125} = 0.216$ oe	A1A1 (4)
	(c)	P($M = 1$) = $(0.5)^3 + 3(0.5)^2(0.2) + 3(0.5)^2(0.3)$	M1
		= 0.5	A1
		P (M = 2) = $\left(\frac{1}{5}\right)^3 + 3\times\left(\frac{1}{5}\right)^2\times\frac{1}{2} + 3\times\left(\frac{1}{5}\right)^2\times\frac{3}{10} + 6\times\frac{1}{2}\times\frac{1}{5}\times\frac{3}{10}$	M1
		= 0.284 or $\frac{71}{250}$ oe	A1
		m | 1 | 2 | 5 P($M = m$) | 0.5 | 0.284 | 0.216	A1 (5) **[11]**

Question Number	Scheme			Marks
3.	P $(X > 6) = \frac{1}{6}$ P$(X < 4) = \frac{1}{2}$ total $= \frac{1}{6}+\frac{1}{2}=\frac{2}{3}$	P$(4 < X < 6) = \frac{1}{3}$ $1-\frac{1}{3}=\frac{2}{3}$	P $(X > 6) = \frac{1}{6}$ Y~U[3,9] P $(Y > 6) = \frac{1}{2}$ total $= \frac{1}{6}+\frac{1}{2}=\frac{2}{3}$	B1 M1 A1 M1dep B A1 (5) **[5]**

4.	Attempt to write down combinations	at least one seen	M1
	(5,5,5), (5,5,10) any order (10,10,5) any order, (10,10,10)		A1
	(5,10,5), (10,5,5), (10,5,10), (5,10,10), (5,5,10)	all 8 cases considered. May be implied by 3 * (10,5,10) and 3 *	A1
	median 5 and 10		B1
	Median = 5 P(M = m) $= \left(\frac{1}{4}\right)^3 + 3\left(\frac{1}{4}\right)^2\left(\frac{3}{4}\right) = \frac{10}{64} = 0.15625$	add at least two prob using ¼ and ¾. identified by having same median of 5 or 10 Allow no 3 for M	M1 A1
	Median = 10 P(M = m) $= \left(\frac{3}{4}\right)^3 + 3\left(\frac{3}{4}\right)^2\left(\frac{1}{4}\right) = \frac{54}{64} = 0.84375$		A1 (7) Total 7

Question Number	Scheme	Marks
5 (a)	$P(T > t) = \dfrac{225}{(t+15)^2}$ $P(T \leq t) = 1 - P(T > t)$ $= 1 - \dfrac{225}{(t+15)^2}$ $F(t) = \begin{cases} 1-\dfrac{225}{(t+15)^2} & t \geq 0 \\ 0 & \text{otherwise.} \end{cases}$	B1 **(1)**
(b)	$P(T < 3) = 1 - \dfrac{225}{(3+15)^2}$ $= \dfrac{11}{36}$ or 0.30555… awrt 0.306	M1 A1 **(2)**
(c)	$P(T > 8 \mid T > 3) = \dfrac{P(T > 8)}{P(T > 3)}$ $= \dfrac{\frac{225}{23^2}}{\frac{225}{18^2}}$ $= \dfrac{324}{529}$ or 0.612.. awrt 0.612 / 0.6125	M1 M1 A1 **(3)**
(d)	$1 - F(t) = 0.1$ $\dfrac{225}{(t+15)^2} = 0.1$ or $1-\dfrac{225}{(t+15)^2} = 0.9$ $\dfrac{225}{0.1} = (t+15)^2$ $t = \sqrt{\dfrac{225}{0.1}} - 15$ t =32.4, also accept 32/33	M1 A1 M1 A1 **(4)** **Total 10**

Question Number	Scheme	Marks
6.	[X = the number of raisins in a mini-muffin]	
(a)	$X \sim$ Po(8)	B1
	e.g. $P(X \leq 3) = 0.0424$, $P(X \leq 13) = 0.9658$ so $P(X \geq 14) = 0.0342$	M1
	So Critical Region is $X \leq 3$ or $X \geq 14$	A1 A1 **(4)**
(b)	0.0424 + 0.0342	M1
	= **0.0766** (or better)	A1 **(2)**
(c)	$H_o : \lambda = 8$ (or μ=80) $H_1 : \lambda > 8$ (or $\mu > 80$)	B1
	[R = no. of raisins in 10 muffins. $R \sim$ Po(80).] Use $Y \sim$ N(80, 80)	M1A1
	$P(R \geq 95) \simeq P(Y \geq 94.5)$	M1
	$= P\left(Z > \frac{94.5-80}{\sqrt{80}}\right)$	M1
	$= P(Z > 1.62...) = 1 - 0.9474 =$ awrt **0.053**	A1
	Probability is greater than 0.05 so not significant (accept H_0)	M1
	Insufficient evidence to support the bakery's claim	A1cso
	Or insufficient evidence of an increase in the (mean) number of raisins per muffin	**(8)** **[14]**

7.	**(a)**	$E(X) = 2$ (by symmetry)	B1 (1)
	(b)	$0 \leq x < 2$, gradient = $\frac{\frac{1}{2}}{2} = \frac{1}{4}$ and equation is $y = \frac{1}{4}x$ so $a = \frac{1}{4}$	B1
		$b - \frac{1}{4}x$ passes through (4, 0) so $b = 1$	B1 (2)
	(c)	$E(X^2) = \int_0^2 \left(\frac{1}{4}x^3\right) dx + \int_2^4 \left(x^2 - \frac{1}{4}x^3\right) dx$	M1 M1
		$= \left[\frac{x^4}{16}\right]_0^2 + \left[\frac{x^3}{3} - \frac{x^4}{16}\right]_2^4$	A1
		$= 1 + \frac{64-8}{3} - \frac{256-16}{16} = 4\frac{2}{3}$ or $\frac{14}{3}$	M1 A1
		$\text{Var}(X) = E(X^2) - [E(X)]^2 = \frac{14}{3} - 2^2$, $= \frac{2}{3}$ (so $\sigma = \sqrt{\frac{2}{3}} = 0.816$) (*****)	M1 A1cso (7)
	(d)	$P(X \leq q) = \int_0^q \frac{1}{4}x \, dx = \frac{1}{4}$, $\frac{q^2}{2} = 1$ so $q = \sqrt{2} = 1.414$ awrt 1.41	M1 A1, A1 (3)
	(e)	$2 - \sigma = 1.184$ so $2 - \sigma$, $2 + \sigma$ is wider than IQR, therefore greater than 0.5	M1, A1 (2) **(15 marks)**

Question Number	Scheme	Marks
8	Let X be the random variable the number of customers asking for water.	
(a)		
(i)	$X \sim B(10,0.6)$; $Y \sim B(10,0.4)$	B1
	$P(X = 6) = (0.6)^6(0.4)^4 \frac{10!}{6!4!}$; $P(Y = 4) = (0.4)^4(0.6)^6 \frac{10!}{6!4!}$	M1
	$= 0.2508\ldots$; $= 0.2508$ awrt 0.251	A1
(ii)	$X \sim B(10,0.6)$; $Y \sim B(10,0.4)$	
	$P(X < 9) = 1 - (P(X = 10) + P(X = 9))$ $= 1 - (0.6)^{10} - (0.6)^9(0.4)^1 \frac{10!}{9!1!}$; $P(X < 9) = 1 - P(Y \leq 1)$ $= 1 - 0.0464$	M1
	$= 0.9536\ldots$; $= 0.9536\ldots$ awrt 0.954	A1
		(5)
(b)	$X \sim B(50,0.6)$	M1
	$Y \sim B(50,0.4)$	
	$P(X < n) \geq 0.9$	
	$P(Y > 50 - n) \geq 0.9$ or $P(X < 34) = 0.8439$ awrt 0.844	
	$P(Y \leq 50 - n) \leq 0.1$ $P(X < 35) = 0.9045$ awrt 0.904/0.905	M1
	$50 - n \leq 15$	
	$n \geq 35$	
	$n = 35$	A1
		(3)
		Total 8

				Mean average scored by candidates achieving grade:							
Qu	**Max Score**	**Modal score**	**Mean %**	**ALL**	**A***	**A**	**B**	**C**	**D**	**E**	**U**
1	5		33.0	1.65	2.45	2.05	1.58	1.26	1.00	0.86	0.72
1	11	11	49.4	5.43	9.02	7.67	5.34	3.57	2.46	1.61	0.81
3	5		41.0	2.05	3.46	2.73	1.87	1.56	1.17	0.95	0.57
4	7		43.1	3.02		4.36	2.86	2.16	1.55	1.07	0.65
5	10	6	49.0	4.86	6.74	5.69	3.71	2.98	2.14	1.56	0.89
6	14		70.3	9.84	12.53	11.20	8.57	7.34	5.43	2.95	2.02
7	15		50.8	7.62		11.27	7.34	5.38	3.69	2.47	1.43
8	8		49.6	3.97	5.62	4.86	3.86	3.36	2.80	2.38	1.40
	75		**51.2**	**38.44**		**49.83**	**35.13**	**27.61**	**20.24**	**13.85**	**8.49**