Mark Scheme 4733
January 2007

For over-specified answers (> 6SF where inappropriate) deduct 1 mark, no more than once in paper.

1	$\frac{22-\mu}{5} = -\Phi^{-1}(0.242)$ $= -0.7$ $\mu =$ **25.5**	M1 A1 B1 A1	**4**	Standardise with Φ^{-1}, allow +, "1 –" errors, cc, $\sqrt{5}$ or 5^2 Correct equation including signs, no cc, can be wrong Φ^{-1} 0.7 correct to 3 SF, can be + Answer 25.5 correct to 3 SF
2	(i) 900 ÷ 12 = **75**	B1	**1**	75 only
	(ii) (a) True, first choice is random	B1	**1**	True stated with reason based on first choice
	(b) False, chosen by pattern	B1	**1**	False stated, with any non-invalidating reason
	(iii) Not equally likely e.g. P(1) = 0, or triangular	M1 A1	**2**	"Not equally likely", or "Biased" stated Non-invalidating reason
3	Let R be the number of 1s $R \sim$ B(90, 1/6) $\approx$ N(15, 12.5) $\frac{13.5-15}{\sqrt{12.5}}$ [= –0.424] **0.6643**	B1 B1 B1 M1 A1 A1	**6**	B(90, 1/6) stated or implied, e.g. Po(15) Normal, $\mu = 15$ stated or implied 12.5 or $\sqrt{12.5}$ or 12.5^2 seen Standardise, np and npq, allow errors in √ or cc or both √ and cc both right Final answer, a.r.t. 0.664. [Po(15): 1/6]
4	(i) $\overline{w} = 100.8 \div 14 = 7.2$ $\frac{938.70}{14} - \overline{w}^2$ [= 15.21] × 14/13 = **16.38**	B1 M1 M1 A1	**4**	7.2 seen or implied Use Σw^2 – their $\overline{w}^2$ Multiply by $n/(n-1)$ Answer, a.r.t. 16.4
	(ii) N(7.2, 16.38 ÷ 70) [= N(7.2, 0.234)]	B1 B1√ B1√	**3**	Normal stated Mean their $\overline{w}$ √ Variance [their (i)√ ÷ 70], allow arithmetic slip
5	(i) $\lambda = 1.2$ Tables or formula used **0.6626**	B1 M1 A1	**3**	Mean 1.2 stated or implied Tables or formula [allow ± 1 term, or "1 –"] correctly used Answer in range [0.662, 0.663] [.3012, .6990, .6268 or .8795: B1M1A0]
	(ii) B(20, 0.6626√) $^{20}C_{13}\ 0.6626^{13} \times 0.3374^{7}$ **0.183**	M1 M1 A1	**3**	B(20, p), p from (i), stated or implied Correct formula for their p Answer, a.r.t. 0.183
	(iii) Let S be the number of stars $S \sim$ Po(24) $\approx$ N(24, 24) $\frac{29.5-24}{\sqrt{24}}$ [= 1.1227] **0.8692**	B1 B1 B1√ M1 A1 A1	**6**	Po(24) stated or implied Normal, mean 24 Variance 24 or 24^2 or √24, √ if 24 wrong Standardise with λ, λ, allow errors in cc or √ or both √λ and cc both correct Answer, in range [0.868, 0.8694]

6	(i)	$\left[ax+\frac{bx^2}{2}\right]_0^2=1$	M1	Use total area = 1
			B1	Correct indefinite integral, or convincing area method
		$2a + 2b = 1$ **AG**	A1 **3**	Given answer correctly obtained, "1" appearing before last line [if + *c*, must see it eliminated]
	(ii)	$\left[\frac{ax^2}{2}+\frac{bx^3}{3}\right]_0^2=\frac{11}{9}$	M1	Use $\int xf(x)dx = 11/9$, limits 0, 2
			B1	Correct indefinite integral
		$2a+\frac{8b}{3}=\frac{11}{9}$	A1	Correct equation obtained, a.e.f.
		Solve simultaneously	M1	Obtain one unknown by correct simultaneous method
			A1	*a* correct, 1/6 or a.r.t 0.167
		$a = \frac{1}{6}$, $b = \frac{1}{3}$	A1 **6**	*b* correct, 1/3 or a.r.t. 0.333
	(iii)	e.g. P(< 11/9) = 0.453, *or*	M1	Use P(x < 11/9), *or* integrate to find median *m*
		$\left[ax+\frac{bx^2}{2}\right]_0^m=0.5,\ m=1.303 \text{ or } \frac{\sqrt{13}-1}{2}$	M1	Substitute into $\int f(x)dx$, √ on *a*, *b*, limits 0 and 11/9 or *m* [if finding *m*, need to solve 3-term quadratic]
		Hence median > mean	A1	Correct numerical answer for probability or *m*
			A1√ **4**	Correct conclusion, cwo ["Negative skew", M2; median > mean, A2]
7	(i)	$H_0: p = 0.35$ [*or* $p \geq 0.35$]	B1	Each hypothesis correct, B1+B1, allow $p \geq .35$ if .35 used
		$H_1: p < 0.35$	B1	[Wrong or no symbol, B1, but *r* or *x* or $\bar{x}$: B0]
		B(14, 0.35)	M1	Correct distribution stated or implied, can be implied by N(4.9, …), but *not* Po(4.9)
	α:	P(≤ 2) = 0.0839 > 0.025	A1	0.0839 seen, *or* P(≤ 1) = 0.0205 if clearly using CR
	β:	CR ≤ 1, probability 0.0205	B1	Compare binomial tail with 0.025, *or* *R* = 2 binomial CR
		Do not reject H_0. Insufficient evidence that proportion that can receive Channel C is less than 35%	M1	Do not reject H_0, √ on their probability, *not* from N or Po or P(< 2); Contextualised conclusion √
			A1√ **7**	
	(ii)	B(8, 0.35): P(0) = 0.0319	M1	Attempt to find P(0) from B(*n*, 0.35)
		B(9, 0.35): P(0) = 0.0207	A1	One correct probability [P(≤ 2) = .0236, *n* = 18: M1A1]
			A1	Both probabilities correct
		Hence largest value of *n* is **8**	A1 **4**	Answer 8 or ≤ 8 only, needs minimum M1A1
	or	$0.65^n > 0.025$; $n \ln 0.65 > \ln 0.025$	M1M1	$p^n > 0.025$, any relevant *p*; take ln, *or* T&I to get 1 SF
		8.56; largest value of *n* = 8	A1A1	In range [8.5, 8.6]; answer 8 or ≤ 8 only
8	(i) α:	$\frac{100.7-102}{5.6/\sqrt{80}}=-2.076$	M1	Standardise 100.7 with √80 or 80
			A1	a.r.t. –2.08 obtained, must be –, *not* from μ = 100.7
		Compare with –2.576	B1 **3**	–2.576 or –2.58 seen and compare *z*, allow both +
	or β:	Φ(–2.076) = 0.0189 [or Φ(2.076) = 0.981]	M1	Standardise 100.7 with √80 or 80
			A1	a.r.t. 0.019, allow 0.981 only if compared with 0.995
		and compare with 0.005 [or 0.995]	B1 (3)	Compare correct tail with 0.005 or 0.995
	or γ:	$102-\frac{k\times5.6}{\sqrt{80}}$	M1	This formula, allow +, 80, wrong SD, any *k* from Φ^{-1}
		k = 2.576, compare 100.7	B1	*k* = 2.576/2.58, – sign, and compare 100.7 with CV
		100.39	A1 (3)	CV a.r.t. 100.4
		Do not reject H_0	M1	Reject/Do not reject, √, needs normal, 80 or √80, Φ^{-1} or equivalent, correct comparison, *not* if clearly μ = 100.7
		Insufficient evidence that quantity of SiO_2 is less than 102	A1 **2**	Correct contextualised conclusion
	(ii) (a)	$\frac{c-102}{5.6/\sqrt{n}}=-2.326$	M1	One equation for *c* and *n*, equated to Φ^{-1}, allow cc, wrong sign, σ^2; 2.326 or 2.33
		$102-c=\frac{13.0256}{\sqrt{n}}$ **AG**	B1	
			A1 **3**	Correctly obtain given equation, needs in principle to have started from *c* – 102, –2.326
	(b)	$\frac{c-100}{5.6/\sqrt{n}}=1.645$ or $c-100=\frac{9.212}{\sqrt{n}}$	M1	Second equation, as before
			A1 **2**	Completely correct, aef
	(c)	Solve simultaneous equations	M1	Correct method for simultaneous equations, find *c* or √*n*
		$\sqrt{n}$ =11.12	A1	√*n* correct to 3 SF
		n_{min} = **124**	A1	n_{min} = 124 only
		c = **100.83**	A1 **4**	Critical value correct, 100.8 or better