Mark Scheme 4733
June 2007

1	(i)	$\hat{\mu}$ = 4830.0/100 = 48.3 249509.16/100 – (their $\bar{x}^2$) × 100/99 = 163.84	B1 M1 M1 A1	**4**	48.3 seen Biased estimate: 162.2016: can get B1M1M0 Multiply by $n/(n-1)$ Answer, 164 or 163.8 or 163.84
	(ii)	No, Central Limit theorem applies, so can assume distribution is normal	B2	**2**	"No" with statement showing CLT is understood (though CLT does not need to be mentioned) [SR: No with reason that is not wrong: B1]
2		B(130, 1/40) ≈ Po(3.25) $e^{-\lambda}\frac{\lambda^3}{4!}$ = 0.180	B1 M1 A1√ M1 A1	**5**	B(130, 1/40) stated or implied Poisson, *or* correct N on their B(n, p) Parameter their np, *or* correct parameter(s)√ Correct formula, or interpolation Answer, 0.18 or a.r.t. 0.180 [SR: N(3.25, 3.17) or N(3.25, 3.25): B1M1A1]
3	(i)	Binomial	B1	**1**	Binomial stated or implied
	(ii)	Each element equally likely Choices independent	B1 B1	**2**	All elements, or selections, equally likely stated Choices independent [not just "independent"] [can get B2 even if (i) is wrong]
4	(i)	*Two of:* Distribution symmetric No substantial truncation Unimodal/Increasingly unlikely further from μ, etc	B1 B1	**2**	One property Another definitely different property Don't give both marks for just these two "Bell-shaped": B1 only unless "no truncation"
	(ii)	Variance $8^2/20$ $z = \frac{47.0-50.0}{\sqrt{8^2/20}} = -1.677$ Φ(1.677) = 0.9532	M1 A1 A1 A1	**4**	Standardise, allow cc, don't need n Denominator (8 or 8^2 or √8) ÷ (20 or √20 or 20^2) z-value, a.r.t. –1.68 or +1.68 Answer, a.r.t. 0.953
5	(i)	H_1: $\lambda > 2.5$ or 15	B1	**1**	$\lambda > 2.5$ or 15, allow μ, don't need "H_1"
	(ii)	Use parameter 15 P(> 23) 1 – 0.9805 = 0.0195 or 1.95%	M1 M1 A1	**3**	λ = 15 used [N(15, 15) gets this mark only] Find P(> 23 or ≥ 23), final answer < 0.5 eg 0.0327 or 0.0122 Answer, 1.95% or 2% or 0.0195 or 0.02 [SR: 2-tailed, 3.9% gets 3/3 here]
	(iii)	P(≤ 23 | λ = 17) = 0.9367 P(≤ 23 | λ = 18) = 0.8989 Parameter = 17 λ = 17/6 or 2.83	M1 A1 M1	**3**	One of these, or their complement: .9367, .8989, 0.9047, 0.8551, .9317, .8933, .9907, .9805 Parameter 17 *[17.1076]*, needs P(≤ 23), cwo [SR: if insufficient evidence can give B1 for 17] Their parameter ÷ 6 *[2.85]* [SR: Solve (23.5 – λ)/√λ = 1.282 M1; 18.05 A0]
6	(i)	H_0: $p = 0.19$, H_1: $p < 0.19$ where p is population proportion $0.81^{20} + 20 \times 0.81^{19} \times 0.19$ = 0.0841 Compare 0.1	B2 M1 A1 A1 B1		Correct, B2. One error, B1, but x or $\bar{x}$ or r: B0 Binomial probabilities, allow 1 term only Correct expression [0.0148 + 0.0693] Probability, a.r.t. 0.084 Explicit comparison of "like with like"
	or	Add binomial probs until ans > 0.1 Critical region ≤ 1	A1 B1		[P(≤ 2) = 0.239]
		Reject H_0 Significant evidence that proportion of *e*'s in language is less than 0.19	M1 A1√	**8**	Correct deduction and method [needs P(≤ 1)] Correct conclusion in context [SR: N(3.8, 3.078): B2M1A0B1M0]
	(ii)	Letters not independent	B1	**1**	Correct modelling assumption, stated in context Allow "random", "depends on message", etc

7	(i)		B1 B1 B1	**3**	Horizontal straight line Positive parabola, symmetric about 0 Completely correct, including correct relationship between two Don't need vertical lines or horizontal lines outside range, but don't give last B1 if horizontal line continues past "±1"
	(ii)	*S* is equally likely to take any value in range, *T* is more likely at extremities	B2	**2**	Correct statement about distributions (*not* graphs) *[Partial statement, or correct description for one only: B1]*
	(iii)	$\int_t^1 \frac{3}{2}x^2 dx = \left[\frac{x^3}{2}\right]_t^1$ ½(1 – t^3) = 0.2 or ½(t^3 + 1) = 0.8 t^3 = 0.6 t = 0.8434	M1 B1 M1 M1 A1	**5**	Integrate f(x) with limits (–1, t) or (t, 1) [recoverable if t used later] Correct indefinite integral Equate to 0.2, or 0.8 if [–1, t] used Solve cubic equation to find t Answer, in range [0.843, 0.844]
8	(i)	$\frac{64.2-63}{\sqrt{12.25/23}} = 1.644$ P(z > 1.644) = 0.05	M1dep A1 dep M1 A1	**4**	Standardise 64.2 with $\sqrt{n}$ z = 1.644 or 1.645, must be + Find Φ(z), answer < 0.5 Answer, a.r.t. 0.05 or 5.0%
	(ii)	(a) $63 + 1.645 \times \frac{3.5}{\sqrt{50}}$ ≥ 63.81	M1 B1 A1	**3**	63 + 3.5 × k / √50, k from Φ^{-1}, *not* – k = 1.645 (allow 1.64, 1.65) Answer, a.r.t. 63.8, allow >, ≥, =, c.w.o.
		(b) P(< 63.8 | μ = 65) $\frac{63.8-65}{3.5/\sqrt{50}} = -2.3956$ 0.0083	M1 M1 A1 A1	**4**	Use of correct meaning of Type II Standardise their c with √50 z = (±) 2.40 [or –2.424 or – 2.404 etc] Answer, a.r.t. 0.008 [eg, 0.00767]
	(iii)	B better: Type II error smaller (and same Type I error)	B2√	**2**	This answer: B2. "B because sample bigger": B1. *[SR: Partial answer: B1]*
9	(a)	np > 5 and nq > 5 0.75n > 5 is relevant n > 20	M2 A1	**3**	Use either nq > 5 or npq > 5 [SR: If M0, use np > 5, or "n = 20" seen: M1] Final answer n > 20 or n ≥ 20 only
	(b)	(i) 70.5 – μ = 1.75σ μ – 46.5 = 2.25σ Solve simultaneously μ = 60 σ = 6	M1 A1 B1 M1 A1√ A1√	**6**	Standardise once, and equate to Φ^{-1}, ± cc Standardise twice, signs correct, cc correct Both 1.75 and 2.25 Correct solution method to get one variable μ, a.r.t. 60.0 or ± 154.5 σ, a.r.t. 6.00 [Wrong cc (below): A1 both] [SR: σ^2: M1A0B1M1A1A0]
		(ii) np = 60, npq = 36 q = 36/60 = 0.6 p = 0.4 n = 150	M1dep depM1 A1√ A1√	**4**	np = 60 and npq = 6^2 or 6 Solve to get q or p or n p = 0.4 √ on wrong cc or z n = 150 √ on wrong cc or z

		σ	μ	q	p (±0.01)	n
70.5	46.5	6	60	0.6	0.4	150
			60.062			
71	46	6.25	5	0.6504	0.3496	171.8
			60.562			
71.5	46.5	6.25	5	0.6450	0.3550	170.6
			59.562			
70.5	45.5	6.25	5	0.6558	0.3442	173.0
71.5	45.5	6.5	60.125	0.7027	0.2973	202.2
70	46	6	59.5	0.6050	0.3950	150.6