Question	Answer	Marks	Guidance
1(a)	Est(μ) = $\frac{4820}{60}$ or $\frac{241}{3}$ or 80.3 (3 sf)	**B1**	
	Est(σ^2) = $\frac{60}{59}(\frac{392\,050}{60} - (\frac{4820}{60})^2)$	**M1**	Use of biased (80.72) score M0 A0.
	82.0904 $\left(\frac{14530}{177}\right)$ to 82.635 or SD = 9.0604 to 9.0904 (3sf)	**A1**	
	z = 2.326	**B1**	
	$\frac{4820}{60} \pm z \times \sqrt{\frac{'82.0904'}{60}}$	**M1**	Expression of the correct form – must be z value.
	77.6 to 83.1 (3 sf)	**A1**	CWO Use of biased 77.6 to 83.0(3) can score B1M1A1 (max 4/6).
		6	
1(b)	Population distribution of times unknown	**B1**	Accept 'not normal'.
		1	

Question	Answer	Marks	Guidance
2(a)	$\frac{1}{2}\times\frac{1}{2}k\times k = 1$	**M1**	Or use of $\int_0^k\left(-\frac{1}{2}x+\frac{1}{2}k\right)\mathrm{d}x=1$ and attempt at integral.
	$k=2$	**A1**	Unsupported answers M0 A0. Do not accept ± 2.
		2	
2(b)	$\mathrm{f}(x)=-\frac{1}{2}x+1$	**B1 FT**	FT *their k* from $y=-\frac{1}{2}x+\frac{1}{2}k$.
	$\int_0^2(-\frac{1}{2}x^2+x)\mathrm{d}x = \left[-\frac{x^3}{6}+\frac{x^2}{2}\right]_0^2$	**M1**	Attempt integration of $x\mathrm{f}(x)$ limits 0 to k. FT *their* $\mathrm{f}(x)$. Could be in terms of k.
	$\frac{2}{3}$ or 0.667 (3 sf)	**A1**	
		3	

Question	Answer	Marks	Guidance
2(c)	$\int_{p}^{1}(-\frac{1}{2}x+1)\mathrm{d}x$ [= 0.25]	**M1**	FT their equation of **line**; correct integral and limits (could be reversed) stated or $\frac{1}{2}(1-p)(1-\frac{1}{2}p+\frac{1}{2})$ [= 0.25].
	$\left[-\frac{x^2}{4}+x\right]_{p}^{1} = 0.25$ $-\frac{1}{4}+1+\frac{p^2}{4}-p = 0.25$	**M1**	Attempt substitution of correct limits (not reversed) into their integral or attempt expand must equal 0.25. OE
	$p^2 - 4p + 2 = 0$	**M1**	Obtain 3-term quadratic set equal to 0, obtain at least 1 solution.
	$p = 2 - \sqrt{2}$ or 0.586	**A1**	CAO
		4	

Question	Answer	Marks	Guidance
3(a)	One-tail because investigating whether "higher"	**B1**	OE. Must have both parts.
		1	
3(b)	H_0: Population mean (or μ) in city same as for others H_1: Population mean (or μ) in city greater than for others	**B1 FT**	If **(a)** two-tail: H_0: Pop mean (or μ) in city same as for others. H_1: Pop mean (or μ) in region different from others.
	2.41 > 2.326 or 0.008 < 0.01 or 0.992 > 0.99	**M1**	If **(a)** two-tail: 2.41 < 2.576 or 0.992 < 0.995.
	There is evidence that buildings are higher [on average].	**A1 FT**	In context, not definite. No contradictions. If **(a)** two-tail: There is no evidence that the [average] height of buildings is different.
		3	

Question	Answer	Marks	Guidance
4(a)	B(1000, $\frac{1}{400}$)	**B1**	Accept Bin and $n = 1000$, $p = \frac{1}{400}$.
		1	
4(b)	Po(2.5)	**B2**	B1 for Po. B1 for $\lambda = 2.5$.
		2	
4(c)(i)	$e^{-2.5} \times \frac{2.5^4}{4!}$	**M1**	FT *their* **(b)** for Normal must have a continuity correction. Allow any λ
	0.134 (3 sf)	**A1**	CWO
		2	
4(c)(ii)	$e^{-2.5}(\frac{2.5^2}{2!} + \frac{2.5^3}{3!} + \frac{2.5^4}{4!})$	**M1**	FT *their* **(b)** for Normal must have a continuity correction. Allow with one term extra or omitted or wrong. Allow any λ.
	0.604 (3 sf)	**A1**	CWO
		2	
4(d)	$\lambda = 2.5 \times 0.7$ or $\lambda = 700 \times \frac{1}{400}$ [= 1.75]	**M1**	Must see λ or use of Poisson.
	$1 - e^{-1.75}$	**M1**	Allow any λ. Allow 1 – P(0,1).
	0.826	**A1**	**SC B1** Use of B(700,0.0025) leading to 0.826.
		3	

Question	Answer	Marks	Guidance
5(a)	$E(L_1+L_2+L_3+S_1+S_2+S_3+S_4) = 3\times5.10+4\times2.51$ [= 25.34]	**B1**	OE (E(3L + 4S – 25.5) = -0.16)
	$\text{Var}(L_1+L_2+L_3+S_1+S_2+S_3+S_4) = 3\times0.0102+4\times0.0036$ [= 0.045]	**B1**	or $\text{SD} = \frac{3\sqrt{2}}{20} = 0.2121$.
	$\frac{25.5-'25.34'}{\sqrt{'0.045'}}$ [= 0.754]	**M1**	No SD/variance mix. Standardising with *their* values (must be from a combination attempt).
	Φ('0.754')	**M1**	For the correct area consistent with *their* working.
	0.775 (3 sf)	**A1**	
		5	
5(b)	$E(L-2S) = 5.10-2\times2.51$ [= 0.08]	**B1**	OE
	$\text{Var}(L-2S) = 0.0102+2^2\times0.0036$ [= 0.0246]	**B1**	Or SD = 0.1568 .
	$\frac{0-'0.08'}{\sqrt{'0.0246'}}$ [= –0.510]	**M1**	No SD/variance mix. Standardising with *their* values (must be from a combination attempt).
	P(Z > '–0.510') = ϕ('0.510')	**M1**	For the correct area consistent with *their* working.
	0.695 (3 sf)	**A1**	
		5	

Question	Answer	Marks	Guidance
6(a)	H_0: population proportion = 0.08 OE H_1: population proportion > 0.08 OE	**B1**	Allow '$p = 0.08$' etc.
	$P(X \geq 4) = 1 - P(X \leq 3) =$ $1 - (0.92^{25} + 25 \times 0.92^{24} \times 0.08 + {}^{25}C_2 \times 0.92^{23} \times 0.08^2 + {}^{25}C_3 \times 0.92^{22} \times 0.08^3)$	**M1**	Allow 1 – (one term omitted or extra or wrong).
	0.135 (3 sf)	**A1**	
	0.135 > 0.05	**M1**	Valid comparison. Note: '0.865'<0.95 can score M1 A1 and can recover previous M1 A1 for 0.865.
	There is no evidence that proportion owning Chantor has increased	**A1 FT**	In context. Not definite, e.g. not 'Proportion not increased'. No contradictions.
		5	
6(b)	H_0 was not rejected.	***B1 FT**	H_0 was rejected (consistent with **(a)**).
	Hence Type II might have been made.	**DB1 FT**	Type I error.
		2	
6(c)	$P(X \geq 5) = 1 - P(X \leq 4)$ $= 1 - \left((1 - 0.1351) + {}^{25}C_4 \times 0.92^{21} \times 0.08^4\right)$ [= 0.0451]	***M1**	Attempted. Note: If critical region method used in **(a)** marks can be awarded here.
	0.0451 < 0.05	**A1**	Comparison of 0.045[1] with 0.05. Note: If critical region method used in **(a)** marks can be awarded here.
	P(Type I error) = 0.0451 or 0.0452	**A1**	Dependent on M1* only. **SC** Unsupported answers score: **B1** for 0.0451<0.05 and **B1** for final answer 0.0451 only.
		3	