Question	Answer	Marks	Guidance
1(i)	Binomial	B1	
	$n = 500$ **and** $p = \frac{1}{150}$ or 0.00667	B1	Or $\mathrm{B}\left(500, \frac{1}{150}\right)$ for B1B1
		2	
1(ii)	Poisson	B1	
	n large and mean $= \frac{10}{3}$ or 3.3 or better, which is < 5	B1	Accept $n > 50$
		2	
1(iii)	$1 - e^{-\frac{10}{3}} \times \left(1 + \frac{10}{3} + \frac{\left(\frac{10}{3}\right)^2}{2}\right)$	M1	1-P(X = 0, 1, 2)
	= 1 – 0.353	A1	Correct expression with λ=3.3 or better
	= 0.647 (3 sf)	A1	**SC** Use of Binomial scores B1 for 0.648. Use of Normal scores B1 for 0.67(0) to 0.677
		3	

Question	Answer	Marks	Guidance
2(i)(a)	Assume standard deviation for the region is 7.1	**B1**	Or standard deviation is same as for whole population OE
	$\dfrac{63.2-65.2}{\frac{7.1}{\sqrt{n}}}=-2.182$	**M1**	Attempt to find correct equation (accept +2.182)
	$n = \{-2.182 \times 7.1 \div (-2)\}^2$	**A1**	Any correct expression for n or $\sqrt{n}$. SOI
	$n = 60$	**A1**	CWO. Must be an integer
		4	
2(i)(b)	H_0: population mean (or μ) = 65.2 H_1: population mean (or μ) < 65.2	**B1**	Not just 'mean'
	2.182 > 1.751	**M1**	Or valid area comparison.
	There is evidence that animals are shorter in this region	**A1**	CWO. No contradictions
		3	
2(ii)	Population unknown or population not given as normal	**B1**	Allow population not normal. Accept distribution of X unknown.
		1	

Question	Answer	Marks	Guidance
3(i)	est(μ) = $\frac{25110}{50}$ (= 502.2)	**B1**	
	$\text{est}\left(\sigma^2\right) = \frac{50}{49}\left(\frac{12610300}{50} - \frac{25110}{50}\right)^2 \left(= \frac{50}{49} \times \frac{58}{50} = 1.1836\right)$	**M1**	OE
	1.18 (3 sf) or $\frac{58}{49}$	**A1**	Accept SD = 1.0879
	z = 2.054 or 2.055	**B1**	
	$502.2 \pm z \times \frac{\sqrt{\text{'}1.1836\text{'}}}{\sqrt{50}}$	**M1**	Must be of correct form.
	501.9 to 502.5 (1dp)	**A1**	CWO. Must be in interval. **SC** accept use of biased variance (1.16) for M1 A1
		6	
3(ii)	More confident **or** z would be greater, Hence wider.	**B1**	OE Reason needed
		1	

Question	Answer	Marks	Guidance
4(i)	$\frac{1}{2}\times a\times\frac{a}{2}=1$ **or** $\frac{1}{2}\int_0^a x\mathrm{d}x=1$ $\frac{a^2}{4}=1$ OE	**M1**	Attempt at triangle area or integral f(x) **and** = 1,
	$a=2$	**A1**	
		2	
4(ii)	$\frac{1}{2}\int_0^2 x^2\mathrm{d}x$	**M1**	Attempt integral xf(x)
	$=\left[\frac{x^3}{6}\right]_0^2$	**M1**	Correct integral and limits 0 to their 'a'
	$\left(=\frac{8}{6}\right)=\frac{4}{3}$	**A1**	AG CWO
		3	

Question	Answer	Marks	Guidance
4(iii)	$P\left(X<\frac{4}{3}\right)=\frac{1}{2}\int_0^{\frac{4}{3}} x\,\mathrm{d}x$	M1	Attempt integral f(x) between correct limits
	$=\frac{4}{9}$	A1	or $\frac{5}{9}$
	$P\left(E(X)<X<m\right)=\frac{1}{2}-\text{'}\frac{4}{9}\text{'}$	M1	or $\frac{5}{9}-\frac{1}{2}$
	$\frac{1}{18}$	A1	
	Alternative method for question 4(iii)		
	Attempt to find m	M1	
	$m=\sqrt{2}$	A1	
	Integrate f(x) between $\frac{4}{3}$ and '$\sqrt{2}$'	M1	
	$\frac{1}{18}$	A1	
		4	

Question	Answer	Marks	Guidance
5(i)	mean = 3250 var. = 61	B1	Or mean = 325 var. $= \frac{6.1}{10}$
	$\frac{3240-3250}{\sqrt{61}}(=-1.280)$	M1	Standardise with their values (no mixed methods)
	$\phi('-1.280') = 1 - \phi('1.280)$	M1	Area consistent with their figures
	0.100	A1	Allow 0.1
		4	
5(ii)	E(D) = 325 – 2 × 167 = –9	B1	Accept ± 9
	$\text{Var}(D) = 6.1 + 2^2 \times 5.6$ (= 28.5)	B1	
	$\frac{0-(-9)}{\sqrt{28.5}}(=1.686)$	M1	Standardising with *their* values. Must have a combination attempt on denominator and $\sqrt{\ }$
	$1 - \phi('1.686')$	M1	Area consistent with their figures
	0.0459	A1	
		5	

Question	Answer	Marks	Guidance
6(i)	H_0: Pop mean (or λ or μ) is 1.1 H_1: Pop mean (or λ or μ) is more than 1.1	**B1**	
	$P(X \geqslant 4) = 1 - e^{-1.1}\left(1 + 1.1 + \frac{1.1^2}{2} + \frac{1.1^3}{3!}\right)$	**M1**	Correct expression for either $P(X \geqslant 4)$ or $P(X \geqslant 5)$
	0.0257	**A1**	Correct value of either $P(X \geqslant 4)$ or $P(X \geqslant 5)$
	$P(X \geqslant 5) = 0.0257 - e^{-1.1} \times \frac{1.1^4}{4!} = 0.00544$	**B1**	B1 for the other value (Note use of $P(X < 4) = 0.9743$ and $P(X < 5) = 0.99456$ can score only if comparison with 0.99 seen)
	$0.00544 < 0.01 < 0.0257$	**M1**	OE stated (valid comparison)
	There is evidence mean has increased	**B1**	**SC** $P(X \geqslant 6) = 0.000968$ M1A1 Conclusion B1
		6	
6(ii)	Concluding mean has increased when it has not	**B1**	In context
	'0.00544'	**B1FT**	FT *their* $P(X \geqslant 5)$, dep < 0.01
		2	
6(iii)	$e^{-7.0}\left(1 + 7 + \frac{7^2}{2} + \frac{7^3}{3!} + \frac{7^4}{4!}\right)$	**M1**	Correct expression for $P(X \leqslant 4 \mid \lambda = 7.0)$
	0.173 (3 sf)	**A1**	
		2	