Qu	Answer	Marks	Notes
1	$192.4 \pm z\sqrt{\frac{43.6}{150}}$	M1	Allow $\frac{43.6}{\sqrt{150}}$ Allow one side for M1
	$z = 2.326$ to 2.329	B1	Condone √(43.6/149) oe
	191 to 194 (3 sf)	A1 [3]	CWO
2	H_0: Pop mean yield = 8.2		or $\mu = 8.2$(not just "mean")
	H_1: Pop mean yield > 8.2	B1	$\mu > 8.2$
	$(\pm)\frac{8.7-8.2}{1.2/\sqrt{16}}$	M1	Allow without √ sign (Allow cc)
	$= (\pm)1.667$	A1	
	Comp $z = 1.645$ Or Area comparison 0.0475-0.0478)	M1	Or comp 1 - Φ('1.667') with 0.05 Valid Comparison z-values (same sign) or areas
	Reject H_0 Evidence that mean yield has increased	A1√ [5]	No Contradictions No follow through for 2 tail test
3 (i)	Use of Poisson	B1	
	Mean = 2.4	B1	
	$1 - e^{-2.4}(1 + 2.4 + \frac{2.4^2}{2})$	M1	Allow any λ *(Allow one end error)*
	$= 0.43(0)$ (3 sf)	A1 [4]	Final answer SR Use of binomial: B1 for ans 0.431 (3 sf)
(ii)	240 > 50 or n>50	B1	
	240 × 0.01 = 2.4 < 5 or np<5 or p<0.1	B1 [2]	SR n large, p small: B1
4 (i)	H_0: Pop mean = 2.5 (or 7.5)		or $\lambda = 2.5$(Not just "mean") Allow μ
	H_0: Pop mean < 2.5 (or 7.5)	B1	or $\lambda < 2.5$
	$\lambda = 7.5$		
	$P(X \leqslant 2) = e^{-7.5}(1+7.5+\frac{7.5^2}{2}) = 0.0203$	M1	Either $P(X\leqslant2)$ or $P(X\leqslant3)$, allow any λ
	$P(X\leqslant3)=0.0203 + e^{-7.5}\times\frac{7.5^3}{3!} = 0.0591$	A1	*Both Correct*
	CR is $X \leqslant 2$	A1	*Clear statement*
	Reject H_0 Evidence that no of sightings fewer	A1√ [5]	*Follow through their CR/their $P(X\leqslant2)$*
(ii)	P(Type I) = 0.0203 (3 sf)	B1√ [1]	ft their $P(X \leqslant 2)$
(iii)	H_0 was rejected oe	B1 [1]	or Type II is P(not reject H_0)oe
5 (i)	$k\int_5^{10}(10t - t^2)dt = 1$	M1	Attempt to integrate, ignore limits
	$k\left[5t^2 - \frac{t^3}{3}\right]_5^{10} = 1$	A1	Correct integral and limits
	$k(500 - \frac{1000}{3} - (125 - \frac{125}{3})) = 1$		
	$k \times \frac{250}{3} = 1$		
	$(k = \frac{3}{250}$ **AG**)	A1 [3]	No errors seen; No inexact decimals seen

Qu	Answer	Marks	Notes
(ii)	$\frac{3}{250}\int_5^{10}(10t^2 - t^3)\mathrm{d}t$	M1	Attempt to integrate, ignore limits
	$= \frac{3}{250}\left[\frac{10t^3}{3} - \frac{t^4}{4}\right]_5^{10}$	A1	Correct integral and limit. Condone missing k
	$= \frac{3}{250}\left(\frac{10000}{3} - \frac{10000}{4} - \left(\frac{1250}{3} - \frac{625}{4}\right)\right)$ = 6.875 or 55/8	A1 [3]	Allow 6.88
(iii)	$P(T < E(T)) = \frac{3}{250}\left[5t^2 - \frac{t^3}{3}\right]_5^{\text{"6.875"}}$	M1*	ft their E(T)
	= 0.5361 "0.5361" – 0.5	DM1*	allow 0.036
	P(T between E(T) & median = 0.0361	A1 [3]	**Alternative Method** Integrate f(t)limits 5 and m equated to 0.5 M1* Integrate f(t)limits their 6.736 (provided between 5 and 10) and their 6.875DM1 Allow without "minutes"
(iv)	10 (minutes)	B1 [1]	
6 (i)	$\lambda = 3.9$	B1	
	$e^{-3.9} \times \frac{3.9^4}{4!}$	M1	M1 allow any λ
	= 0.195	A1 [3]	SR Combination method B1 for λ =1.6 AND λ =2.3 used in combination method (at least 3 combinations) M1 All correctly combined and added
(ii)	$\bar{X} \sim N(1.6, \frac{1.6}{75})$	B1 B1 [2]	B1 for N(1.6, ….)stated B1 for Var = $\frac{1.6}{75}$ stated SR, not stated but all implied in (iii): B1
(iii)	$\frac{1.7-1.6}{\sqrt{\frac{1.6}{75}}}$ (= 0.685)	M1	For standardising (using their values or correct values .Ignore cc
	1– Φ("0.685") = 0.247 (3 sf)	M1 A1 [3]	Correct area consistent with their working Accept use of 1/2n correction leading to 0.233. NB Use of Poisson sum Po(120) and N(120,120) with μ=127.5 leads to 0.247, or 0.233 with cc
(iv)	X not normally distr. So CLT needed	B1 [1]	Not "it"

Qu	Answer	Marks	Notes
7 (i)	E(T) =20.8 Var(T)= 20 × 0.03^2 + 0.01^2(= 0.0181) $\frac{20.6-20.8}{\sqrt{"0.0181"}}$ (= –1.487) 1 – Φ(“1.487”) = 0.0684 to 0.686	B1 B1 M1 M1 A1 [5]	 or √(20 × 0.03^2 + 0.01^2) = 0.135 (3sf) For standardising (σ must come from combination) Area consistent with their working Any answer within range
(ii)	E(D) = 0 Var(D) = 2 × 0.0181(= 0.0362) $\frac{0.02-0}{\sqrt{"0.0362)}}$ (= 0.105) Φ(“0.105”) = 0.5418 or 1-Φ(0.015) =0.4582 Φ(“0.105”) – (1 – Φ(“0.105”) (= 0.5418 – 0.4582) = 0.0836/0.0837	 B1√ M1 A1 M1 A1 [5]	 Both (Seen or implied) Allow without √ Allow to 3sf or 1 – 2(1 – Φ(“0.105”)) (= 1 – 2 × 0.4582)