1		Var = 16×9 + 25×36 (= 1044) sd = 32.3 or 6√29 or √1044	B1 M1 A1	M1 for 16 (or 4²) & 25 (or 5²) used M1 for add any multiples of 9 and 36 only
		Total	**3**	
2	**(i)**	H_0: $\lambda = 0.5$ H_1: $\lambda > 0.5$	 B1 1	or Pop mean = 0.5, not just Mean = 0.5 or Pop mean (per m^2)= 0.1 Accept μ instead of λ
	(ii)	$1 - e^{-0.5}(1 + 0.5)$ = 0.0902 (3 sf) comp 0.1 Claim justified or there is evidence to support claim	M1 A1 M1 A1√ 4	$1 - P(X = 0,1)$ attempted, any λ. Allow 1 end error Allow 0.09 Valid comparison NB 0.9098>0.9 recovers M1A1 M1 oe Accept 'Reject H_0' if correctly defined No contradictions.
		Total	**5**	
3		$\lambda = 5 \times 0.15$ (= 0.75) E(amount) = 200×0.75 = 150 Var(weekly no of hole–in–ones) = 0.75 Var(amount) = $200^2 \times 0.75$ = 30,000	M1 A1 B1√ M1 A1 5	 Allow 200^2 × their variance (with nothing added/subtracted at any stage) (SR probability table can score M1A0 srB1 if var rounds to 30,000 (2sf))
		Total	**5**	
4	**(i)**	Conclude flight times affected when in fact they have not been.	B1 B1 2	Or accept pop mean changed from 6.2 although pop mean has not changed from 6.2
	(ii)	H_0: Pop mean (or μ) = 6.2 H_0: Pop mean (or μ) ≠ 6.2 $\frac{5.98 - 6.2}{\frac{0.8}{\sqrt{40}}}$ = –1.739 (±) Accept (±)1.74 comp z = 1.96 No evidence that flight times affected	 B1 M1 A1 B1√ 4	 Allow with 40 instead of √40 Allow SD/Var mix (CV method 5.952 or 6.2279 M1 A1) For valid comparison or $P(z < -1.739) = 0.041 > 0.025$ or 5.98 > 5.952 or 6.2 < 6.228 and correct conclusion
	(iii)	H_0 was not rejected oe Type II	B1* B1*dep 2	If in (ii) H_0 was rejected, then: H_0 rejected B1; Type I B1dep
		Total	**8**	

5	**(i)**	14800/50 or 296 $\frac{50}{49}\left(\frac{4390000}{50} - '296'^2\right)$ (= 187.755) = 188 (3 sf)	B1 M1 A1 3	Oe
	(ii)	$2 \times z \times \sqrt{\frac{'187.755'}{50}} = 5.45$ oe z = 1.406 or 1.405 Φ('1.406') (= 0.92 or 0.9199) α = 84 (2 sf) allow 83.98	M1 A1 M1 A1 4	If '2 ×' omitted: $z \times \sqrt{\frac{'187.755'}{50}} = 5.45$ M1 z = 2.812 or 2.810 A0 Φ('2.812') (= 0.9975) α = 99.5 or 99 or 100 M1 A0 For complete method to find α SR use of biased var(184) scores M1A1(1.4205) A=84.5 M1A1
	(iii)	0.96^4 = 0.849 (3 sf)	M1 A1 2	
		Total	**9**	
6	**(i)**	$k\int_0^{15}(225 - t^2)\mathrm{d}t = 1$ $k\left[225t - \frac{t^3}{3}\right]_0^{15} = 1$ k×[3375 – 1125} = 1 or k×2250 = 1 ($k = \frac{1}{2250}$ **AG**)	M1 A1 A1 3	Attempt integ f(x) and = 1. Ignore limits Correct integration and limits No errors seen
	(ii)	$\frac{1}{2250}\int_{10}^{15}(225 - t^2)\mathrm{d}t$ $(= \frac{1}{2250}\left[225t - \frac{t^3}{3}\right]_{10}^{15})$ $= \frac{1}{2250}$ [2250 – (2250 – $\frac{1000}{3}$)] $= \frac{4}{27}$ or 0.148 (3 sf)	M1 A1 A1 3	Attempt integ, ignore limits Or $1 - \int_0^{10}$ Correct integration and limits. Condone missing k
	(iii)	$\frac{1}{2250}\int_0^{15}(225t - t^3)\mathrm{d}t$ $= \frac{1}{2250}\left[\frac{225t^2}{2} - \frac{t^4}{4}\right]_0^{15}$ $= \frac{1}{2250}[\frac{50625}{2} - \frac{50625}{4}]$ $= \frac{45}{8}$ or 5.625 or 5.63 (3 sf)	M1* A1 M1*dep A1 4	Attempt integ xf(x) , ignore limits Correct integration and limits. Condone missing k Sub correct limits into their integral Accept 5 mins 37 or 38 secs
		Total	**10**	

7	(i)	Poisson	B1	
		(Actually binomial with)		Allow without "binomial"
		$n > 50$	B1	Accept n large
		and np (or λ) (= 2.1) which is < 5	B1 3	Accept p small (p < 0.1)
	(ii)	$\lambda = 2.1$	B1	
		$e^{-2.1}\left(1+2.1+\frac{2.1^2}{2}+\frac{2.1^3}{3!}\right)$	M1	Attempt P(0,1,2,3) any λ allow 1 end error
				SR_1 Ft Normal N(2.1,2.1) B1 standardising M1
		= 0.839 (3 sf)	A1 3	0.833 A1
				SR_2 Ft Binomial B(10500,0.0002) B1 calculating binomial prob P(0,1,2,3) M1 = 0.8386 A1
	(iii)	$P(X \geqslant 1) = 1 - e^{-2.1}$ (= 0. 87754)	M1	Any λ
		$P(X = 1,2,3) = e^{-2.1}\left(2.1+\frac{2.1^2}{2}+\frac{2.1^3}{3!}\right)$ (= 0.71619)	M1	Or '0.839' – $e^{-2.1}$ Any λ
		$\frac{P(X=1,2,3)}{P(X>1)}$ $\left(=\frac{0.71619}{0.87754}\right)$	M1	Allow any attempted $\frac{P(X=1,2,3)}{P(X>1)}$ Any λ
		= 0.816 (3 sf)	A1 4	SR_1 Ft Normal P(>0.5)=0.86523 M1 P(1,2,3)=0.698 M1 0.698/0.86523 = 0.807 M1A1
				SR_2 FT Binomial M1 M1 M1 A1
		Total	**10**	
		Total for paper	**50**	