1	$\frac{\Sigma x}{8} = \frac{2006}{8}$ = 250.75 or 251 (3 s.f.)	B1	Any equivalent form
	(Σx^2 = 503274)		
	$\frac{8}{7}\left(\frac{\text{"503274"}}{8} - \text{"250.75"}^2\right)$	M1	For use of formula of correct form
	= 38.5 o.e. (accept 6.204^2)	A1 [3]	cao (as final answer)
2	$(X + Y - Z) \sim N(8, \ldots)$		
	μ=8 (or –8)	B1	seen or implied
	$\text{Var}(X + Y - Z) = 2^2 + 1.5^2 + 1.8^2$ (= 9.49)	B1	– award at early stage
	$\frac{0-8}{\sqrt{\text{'9.49'}}}$ (= –2.597)	M1	For standardising (accept sd/var mixes, but variance must be a combination of at least 2 of X, Y, Z)
	Φ('–2.597') = 1 – Φ('2.597')	M1	For area consistent with their working
	= 0.0047	A1 [5]	
3	H_0: Pop mean (or μ or λ) = 50 (or 5)		
	H_1: Pop mean (or μ or λ) ≠ 50 (or 5)	B1	Not just "mean"
	$\frac{60.5-50}{\sqrt{50}}$ (±)	M1	For standardising with N(50,50) or N(5,5/√10)
	= (±)1.485 OR 0.0687 OR C.V	A1	Allow M1 with wrong or no continuity correction OR no √ (accept c.v method M1, A1 for 61.63 or 48.868)
	1.485 < 1.645 or 0.0687 > 0.05 No evidence that mean changed	M1 A1√ [5]	For valid comparison (zs or areas or cv) (S.R For cv comparison 61.63 only award final A1 if cc used) or if H_1: λ > 50, 1.485 < 1.96 M1 No evid mean changed A0 (i.e. if one-tail test, max B0 M1 A1 M1 A0)

4 (i)	$\lambda = 4.5$	B1	seen
	$1 - e^{-4.5}\left(1 + 4.5 + \frac{4.5^2}{2}\right)$	M1	any λ. Allow one end error
	$= 0.826$ (3 s.f.)	A1 [3]	
(ii)	$e^{-\lambda} = 0.523$	B1	
	$(-\lambda = \ln 0.523)$		
	$\lambda = 0.648$ (3 s.f.)	B1 [2]	
(iii)	$e^{-\mu} \times \frac{\mu^3}{3!} = 24 \times e^{-\mu} \times \mu$	B1	
	$\frac{\mu^2}{6} = 24$	M1	For a simplified expression in μ^2 with $e^{-\mu}$ and μ cancelled and no factorials.
	$\mu = 12$	A1 [3]	
5 (i)	$p = \frac{184}{400}$ or 0.46	B1	Used
	$z = 1.96$	B1	Seen
	$\text{"0.46"} \pm z \times \sqrt{\frac{\text{"0.46"}(1-\text{"0.46"})}{400}}$	M1	Using expression of correct form
	$= 0.411$ to 0.509	A1 [4]	Must be an interval
(ii)	0.5 within CI		
	Claim not supported or not justified	B1√ [1]	Both needed. No contradictions. ft their **(i)**
(iii)	$z \times \sqrt{\frac{\text{"0.46"}(1-\text{"0.46"})}{400}} = 0.05$	M1	Allow M1 for $z \times \sqrt{\frac{\text{"0.46"}(1-\text{"0.46"})}{400}} = 0.1$
	$z = 2.006$	A1	
	$\Phi(\text{‘}2.006\text{’}) = 0.9775$		
	$\alpha = \text{‘}0.9775\text{’} - (1 - \text{‘}0.9775\text{’})$	M1	or $1 - 2(1 - \text{‘}0.9775\text{’})$
	$= 95.5\%$	A1 [4]	

6 (i)	$k\int_0^4 (16t - t^3)\,dt = 1$	M1		Int f(t) = 1 ignore limits
	$k\left[8t^2 - \frac{t^4}{4}\right]_0^4 = 1$	A1		correct integration with correct limits
	$k(128 - 64) = 1$ o.e.			
	$k \times 64 = 1$			
	$\left(k = \frac{1}{64}\right)$ **AG**	A1	[3]	must be convinced (AG)
(ii)	$\frac{1}{64}\int_0^1 (16t - t^3)\,dt$	M1		Int f(t) between 0 and 1 (accept 0 and a value < 1 , 1 and 4)
	$= \frac{1}{64}\left[8t^2 - \frac{t^4}{4}\right]_0^1$	A1		correct integration and correct limits (ignore "k")
	$= \frac{1}{64}\left[8 - \frac{1}{4}\right]$			
	$= \frac{31}{256}$ or 0.121094	A1		
	$\left(\frac{31}{256}\right)^2 = 0.0147$ (3 s.f.) o.e.	B1√	[4]	ft their "$\frac{31}{256}$"
iii	$\frac{1}{64}\int_0^4 (16t^2 - t^4)\,dt$	M1		Int tf(t) ignore limits
	$= \frac{1}{64}\left[\frac{16t^3}{3} - \frac{t^5}{5}\right]_0^4$	A1		correct integration and correct limits (ignore "k")
	$= \frac{1}{64}\left(\frac{1024}{3} - \frac{1024}{5}\right)$			
	$= \frac{32}{15}$ or 2.13 (3 s.f.) o.e.	A1	[3]	

7 (i)	2^{nd} More representative of all appointments or Lengths may vary during the day or 1^{st} does not include later appts so not representative	B1 B1 [2]	Any implication that times or conditions vary throughout day, e.g. doctors get tired		
(ii)	0.01 o.e. Concluding that times spent are too long when they are not.	B1 B1 [2]	Concluding that the mean time spent is more than 10 mins when it is not. Must be in context.		
(iii)	H_0: Pop mean appt time (or μ) = 10 H_1: Pop mean appt time (or μ) > 10	B1	Both correct. Allow μ, but not just "mean"		
	$\dfrac{\frac{147}{12}-10}{\frac{3.4}{\sqrt{12}}}$ (±)	M1	Allow incorrect $\frac{147}{12}$ Must have $\sqrt{12}$ (accept totals method)	$10 + 2.326 \times \frac{3.4}{\sqrt{12}}$ M1 = 12.28 A1	
	= (±)2.292 or (0.0109 if area comparison done)	A1			
	"2.292" < 2.326 o.e.	M1	For valid comparison Comp "2.292" with 2.326 Or 0.0109 with 0.01 Or 147/12 with 12.28	$\frac{147}{12}$ < 12.28 M1	
	(No evidence to reject H_0.) No reason to believe appts are too long	A1√ [5]	Dep 2.326, ft their "2.292" No contradictions		
(iv)	Normal population	B1 [1]	Must have "population" or equiv		