Question	Answer	Marks	Guidance
1	$(\lambda =)\ \frac{5}{12} = 0.417$ or better	**B1**	
	$1 - e^{-\frac{5}{12}}(1 + \frac{5}{12})$	**M1**	1 – P(X = 0 or 1), by Poisson, using any λ, allow 1 – P(X = 0 or 1 or 2) for M1
	= 0.0661 or 0.0662 (3 sf)	**A1**	Final answer **SC** use of Binomial (from 0.06607…) B1 only
		3	

Question	Answer	Marks	Guidance
2	$2 \times z \times \frac{3.2}{10} = 1.25$	**M1**	OE Allow without '2 ×'
	$z = 1.953$	**A1**	SOI
	ϕ('*their* 1.953') (= 0.9746)	**M1**	
	= 1 – 2(1 – '0.9746') = 0.9492	**M1**	OE
	$\alpha = 94.9$ or 95	**A1**	CWO
		5	

Question	Answer	Marks	Guidance
3(a)	est (μ) = 37.6 or $\frac{1504}{40}$ or $\frac{188}{5}$	**B1**	
	est (σ^2) = $\frac{40}{39}\left[\frac{57760}{40} - 37.6^2\right] = 31.0154 = \frac{2016}{65}$	**M1**	Correct substitution in any correct formula $\frac{1}{39}\left[57760 - \frac{1504^2}{40}\right]$
	= 31.(0) (3 sf)	**A1**	Accept $\frac{2016}{65}$ or $31\frac{1}{65}$
		3	
3(b)	H_0: Pop mean (or μ) = 39.2 H_1: Pop mean (or μ) < 39.2	**B1**	Both. Not just 'mean'
	$\dfrac{'37.6'-39.2}{\frac{\sqrt{'31.0154'}}{\sqrt{40}}}$	**M1**	Allow use of biased variance (30.2), must have √40
	= –1.817	**A1**	**SC** FT use of biased = –1.840 for A1
	'1.817' > 1.645 OE	**M1**	Valid comparison '*their* 1.817' with 1.645 or valid area comparison 0.0346 < 0.05 OE
	There is evidence that mean time has decreased	**A1FT**	FT *their* 1.817; in context, not definite, no contradictions **SC** For 2 tail test: H_1: $\mu \neq 39.2$ and comp 1.96, max B0M1A1M1A0 (no FT for final mark)
		5	

Question	Answer	Marks	Guidance
4(a)	λ $(= 0.4 \times 365 \div 50) = 2.92$	**B1**	
	$e^{-2.92}(1 + 2.92 + \frac{2.92^2}{2})$	**M1**	Any λ. Allow one end error
	$= 0.441$ (3 sf)	**A1**	
		3	
4(b)	$e^{-\lambda} > 0.95$	**M1**	Allow '=' throughout
	$-\lambda > \ln 0.95$ or $\lambda < 0.051293$ OE	**M1**	Attempt ln both sides
	'0.051293' $\times 50 \div 0.4$ $(= 6.411)$	**M1**	
	Largest n is 6 (3 sf) Allow $n = 6$ or $n \leqslant 6$ (NOT $n < 6$ or $n \geqslant 6$ as final answer)	**A1**	**SC** Trial and Improvement M1 for $e^{-\lambda} > 0.95$ SOI; M1 for $\lambda = n \times \frac{0.4}{50}$; M1 for use of both $n = 6$ giving 0.9531 and $n = 7$ giving 0.9455; A1 $n = 6$
		4	

Question	Answer	Marks	Guidance
5(a)	$\frac{3}{4000}\int_5^{10}(100-x^2)\mathrm{d}x$ $=\frac{3}{4000}\left[100x - \frac{x^3}{3}\right]_5^{10}$	M1	Attempt integration of f(x), ignore limits. Condone omission of $\frac{3}{4000}$
	$=\frac{3}{4000}(1000-\frac{1000}{3}-500+\frac{125}{3})$	M1	Correct limits 5 and 10. OE SOI
	$= 0.156$ (3 sf) or $\frac{5}{32}$	A1	For fully correct working seen including substitution of limits
		3	
5(b)	$\frac{3}{4000}\int_p^{10}(100-x^2)\mathrm{d}x = \frac{1}{4}$	M1	Attempt integration of f(x) with any limits and $=\frac{1}{4}$ or $=\frac{3}{4}$ seen. Condone omission of $\frac{3}{4000}$
	$\frac{3}{4000}\left[100x-\frac{x^3}{3}\right]_p^{10} = \frac{1}{4}$	A1	Correct integration with correct limits seen (or implied for limits p and 10) and $=\frac{1}{4}$ OE Condone omission of $\frac{3}{4000}$
	$\frac{3}{4000}(1000-\frac{1000}{3}-100p+\frac{p^3}{3})=\frac{1}{4}$	M1	Attempt substitution correct limits in their integration of f(x). Accept limits 0 to p if clearly seen, accept limits –10 and p. Substitution must be seen.
	e.g. $\frac{2000}{3}-100p+\frac{p^3}{3}=\frac{1000}{3}$ $p^3-300p+1000=0$	A1	AG No errors seen
		4	

Question	Answer	Marks	Guidance
5(c)	Curve is symmetrical about $x = 0$	**B1**	May be implied by sketch. No contradictions or integrate f(x) between $-q$ and $+q$ and equate to 0.5 leading to q^3 -300q + 1000 = 0 oe
	$q = 3.47$	**B1**	
		2	

Question	Answer	Marks	Guidance
6(a)	N(310, 50)	**B1**	SOI
	$\frac{300-'310'}{\sqrt{'50'}}$ (= –1.414)	**M1**	Standardise using their values
	Φ('–1.414') = 1 – ϕ('1.414')	**M1**	Area consistent with their values
	= 0.0786 or 0.0787 (3 sf)	**A1**	As final answer
		4	

Question	Answer	Marks	Guidance
6(b)	$P(L - 2S > 0)$	**M1**	OE SOI
	$E(X) = 200\text{-}2\text{x}110$ or $= -20$	**B1**	OE seen
	$\text{Var} = 30 + 2^2 \times 20$ or $= 110$	**B1**	Seen
	$N(-20, 110)$ $\dfrac{0-('-20')}{\sqrt{'110'}}$ $(= 1.907)$	**M1**	Standardising with their values. Mean and variance must come from a combination attempt.
	$1 - \Phi(\text{'}1.907\text{'})$	**M1**	Correct area consistent with their working
	$= 0.0283$ (3 sf)	**A1**	Final answer
		6	

Question	Answer	Marks	Guidance
7(a)	$P(X \leqslant n)$ $(n \leqslant 20)$ attempted, using $B(20, 0.95)$	**M1**	OE
	$P(X \leqslant 17)$ <u>or</u> $P(X \leqslant 16)$ attempted, using $B(20, 0.95)$	**M1**	OE
	$(P(X \leqslant 17)) = 0.0755$ <u>and</u> $(P(X \leqslant 16)) = 0.0159$	**A1**	OE (0.925 and 0.984) both correct
	Rej region is $X \leqslant 16$ or $X < 17$	**A1**	Dependent on M1M1 and previous answers correct to at least 0.075/0.076 and 0.016 **or** 0.92/0.93 and 0.98 Correct unsupported answers of 0.0755 and 0.0159 OE scores M1 M1 A0
		4	

Question	Answer	Marks	Guidance
7(b)	0.0159	**B1**	FT *their* rejection region, from Binomial in a, if P(X in rejection region) < 0.025
		1	
7(c)	Use of B(20, 0.7)	**M1**	
	$P(X > 16 \mid p = 0.7)$	**M1**	Correct method using B(20, 0.7)
	= 0.107	**A1**	
		3	