1	$\left(\frac{508}{8}\right) = 63.5$ $(\Sigma x^2 = 32360.12)$ $\frac{8}{7}\left(\frac{'32360.12'}{8} - '63.5'^2\right)$ $= 14.6$ (3 sf) or 2553/175	**B1** **M1** **A1**	[3]	 oe From correct working
2 (i)	H_0: P(6) = $^1/_6$ H_1: P(6) < $^1/_6$	**B1**	[1]	Allow H_0: $p = {}^1/_6$ H_1: $p < {}^1/_6$
(ii)	$\left(\frac{5}{6}\right)^{15}$ $= 0.065 > 0.05$	**M1** **A1**	[2]	 Correct result and comparison needed for A1 SR if 2 tail test followed allow A1 for $0.065 > 0.025$
(iii)	$\left(\frac{5}{6}\right)^{16} = 0.054$ and $\left(\frac{5}{6}\right)^{17} = 0.045$ Smallest n is 17 **OR** $\left(\frac{5}{6}\right)^n < 0.05$ and attempt to solve $n\ln\left(\frac{5}{6}\right) < \ln 0.05$ smallest n is 17	**M1** **A1** **M1** **A1**	[2]	both No errors seen
3 (i)	$(\lambda) = 3.6 \div 3 = 1.2$ $1 - e^{-1.2}\left(1 + 1.2 + \frac{1.2^2}{2} + \frac{1.2^3}{3!}\right)$ $= 0.0338$ (3 sf)	**B1** **M1** **A1**	[3]	1.2 seen Allow any λ As final answer
(ii)	N(60 × 3.6, 60 × 3.6) $\frac{240.5 - '216'}{\sqrt{'216'}}$ (= 1.667) 1– Φ(‘1.667’) = 0.0478 (3 sf)	**M1** **M1** **M1** **A1**	[4]	Stated or implied Allow with no or wrong cc (no sd/var mixes) Area consistent with their working SR use of Poisson 0.0497 scores 4/4
4 (i)	6080 (litres) 106 (litres)	**B1** **B1**	[2]	
(ii)	$E(21Y - 2X) = 635$ $Var(21Y - 2X) =$ $21^2 \times 12^2 + 2^2 \times 53^2$ (= 74740) $\frac{0 - 635}{\sqrt{'74740'}}$ (= –2.323) 1–Φ(‘–2.323’) = Φ(‘2.323’) = 0.99(0) (3 sf)	**B1** **B1** **M1** **M1** **A1**	[5]	 correct expression or result or sd = 273 seen no sd/var mixes Area consistent with their working No errors seen
5 (a)	$63 \pm z \times \frac{9}{\sqrt{100}}$ $z = 1.645$ 61.5 to 64.5 (3 sf)	**M1** **B1** **A1**	B1 [3]	Expression of correct form, any z Seen Must be an interval

(b) (i)	$z = \frac{1.96}{2}$ (= 0.98) Φ("0.98") (= 0.8365) "0.8365" – (1 – "0.8365") (= 0.673) $\alpha = 67.3$ (3 sf)	**M1** **M1** **A1**	[3]	Allow $\frac{\text{any } z}{2}$ Allow 67 from correct working
(ii)	$4=(2x'z'x'\sigma')/\sqrt{n}$ $n = 200$	**M1** **A1**	[2]	Attempt to solve equ of correct form SR B1 for $n = 100$
6 (i)	m_X, m_Y, m_Z, m_W or *X, Y, Z, W*	**B2**	[2]	B1 if two adjacent means interchanged, i.e. m_Y, m_X, m_Z, m_W or m_X, m_Z, m_Y, m_W or m_X, m_Y, m_W, m_Z B1 for correct order reversed.
(ii) (a)	$\int_0^3 \frac{4}{81}x^4 \mathrm{d}x$ $= \left[\frac{4}{81}\frac{x^5}{5}\right]_0^3$ $= \frac{4}{81}\times\frac{3^5}{5}$ or $\frac{4}{81}\times\frac{243}{5}$ or $\frac{972}{405}$ oe $= \frac{12}{5}$ or 2.4 AG	**M1** **A1** **A1**	[3]	Attempt int $xf(x)$. Ignore limits Correct integration and limits (condone missing 4/81) Must see correct expression as well as $\frac{12}{5}$ or 2.4 No errors seen
(b)	$\int_{2.4}^3 \frac{4}{81}x^3 \mathrm{d}x$ or $1 - \int_0^{2.4} \frac{4}{81}x^3 \mathrm{d}x$ $= \left[\frac{4}{81}\frac{x^4}{4}\right]_{2.4}^3$ or $1 - \left[\frac{4}{81}\frac{x^4}{4}\right]_0^{2.4}$ $= 1 - \frac{4}{81}\times\frac{2.4^4}{4}$ oe $= \frac{369}{625}$ or 0.59(0) (3 sf)	**M1** **A1** **A1**	[3]	Attempt int $f(x)$ ignore limits Correct integration and limits (condone missing 4/81) As final answer
(c)	1	**B1**	[1]	

7 (i)	H_0: Pop mean time (or μ) = 20.5 H_1: Pop mean time (or μ) < 20.5	**B1**		Not just "mean"
	$\frac{20.3-20.5}{1.2\div\sqrt{100}}$	**M1**		Allow without √ sign
	= –1.667 or 0.0478/0.952 if areas compared	**A1**		(accept ±1.667/1.67)
	'1.667' < 1.751 (or '–1.667' > –1.751)	**M1**		Correct comparison of their z_{calc} with 1.751/1.75 oe valid comparison of areas (0.0478 > 0.04)
	No evidence that (pop) mean time has decreased	**A1ft**	[5]	No contradictions (ft their z)
(ii)	$\frac{cv-20.5}{1.2\div\sqrt{100}}$ = –1.751	**M1***		
	cv = 20.29 or 20.3	**A1**		
	$\frac{'20.29'-20.1}{1.2\div\sqrt{100}}$ (= 1.583 or 1.582)	**DM1**		Allow $\frac{20.3-20.1}{1.2\div\sqrt{100}}$ (= 1.667) M1
	1 – Φ('1.583') = 0.0567 – 0.0569 (3 sf)	**M1** **A1**	[5]	1 – Φ('1.667') M1 = 0.0478 (3 sf) A1
(iii)	Concluding (mean) time not decreased when in fact it has.	**B1**	[1]	Must be in context oe