Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to $\geq$ 3sfs, ISW for later rounding. Penalise < 3 sfs only once in paper.

1	N(483.2, 537.92) or N(483.2, 23.2^2)	B1	or $\frac{8.2}{\sqrt{8}}$ or $\frac{8.2^2}{8}$ seen or implied
	$\frac{436-483.2}{\sqrt{537.92}}$ or $\frac{436-483.2}{23.2}$ (= –2.035)	M1	or $\frac{\frac{436}{8}-60.4}{8.2/\sqrt{8}}$ standardising (no mixed methods)
	Φ("–2.035") = 1 – Φ("2.035")	M1	Correct area consistent with their working
	= 0.021 or 2.1%	A1 [4]	
		[Total: 4]	
2	$\frac{70}{69}\times 2.70$ = 2.73913	M1A1	
	$3.61 \pm z\sqrt{\frac{\text{"2.73913"}}{70}}$	M1	or $3.61 \pm z\sqrt{\frac{2.70}{69}}$ M2A1(implied)
			without $\frac{70}{69}$: $3.61 \pm z\sqrt{\frac{2.70}{70}}$ M0A0M1
	z = 1.96	B1	z = 1.96 B1
	3.22 to 4.00 (3 sf)	A1 [5]	3.23 to 3.99(4.00) (3 sf) A1
			Answer must be an interval
		[Total: 5]	
3	H_0: μ = 250 H_1: μ > 250	B1	Both hypotheses
	$\frac{250.06-250}{0.2\div\sqrt{40}}$	M1	M1 for standardising, must have √40.
	= 1.90	A1	Accept cv method
	comp with z = 1.645	M1	For valid comparison "1.90" with 1.645 or area comparison or CVs
	Claim is justified or There is evidence that claim is true	A1√ [5]	Correct conclusion. No contradictions
			NB 2-tail test scores B0 M1 A1 M1 (use 1.96) A0
		[Total: 5]	
4 (i)	B(3500, 0.001)	B1	
	Poisson with mean = 3.5	B1	or Po(3.5)
	n > 50 and np < 5	B1 [3]	Both. Or n > 50 and λ < 5 or 3.5 < 5
(ii)	$e^{-3.5}(1 + 3.5 + \frac{3.5^2}{2}+\frac{3.5^3}{3!})$	M1	Allow any λ
	= 0.537 (3 dp)	A1 [2]	
		[Total: 5)	

5	**(i)**	$0.25(1+4+9)-1.5^2$ (=1.25 **AG**)	B1 [1]	
	(ii)	$\dfrac{1.4-1.5}{\sqrt{\frac{5}{4}\div 300}}$ (= –1.549) Φ("–1.549") = 1 – Φ("1.549") = 0.0607 (3 sf)	M1 M1 A1 [3]	$\dfrac{1.4-\frac{1}{600}-1.5}{\sqrt{\frac{5}{4}\div 300}}$ (= –1.523) Φ("–1.523") = 1 – Φ("1.523") = 0.0639 (3 sf)
	(iii)	Large sample or large *n* ($\overline{X}$ (approx) normally distr) or Central Limit Theorem	B1 [1]	
			[Total: 5]	
6	**(i)**	H_0: Rate = 0.9 H_1: Rate < 0.9 1 – P(17, 18, 19, 20) $1-({}^{20}C_{17}\times 0.1^3\times 0.9^{17}+{}^{20}C_{18}\times 0.1^2\times 0.9^{18}+20\times 0.1\times 0.9^{19}+0.9^{20})$ = 0.133 (3 sf)	 B1 M1 M1 A1 [4]	p = 0.9 p < 0.9 Use of B(20,0.1) Allow 1–P(18,19,20) or 1–P(16,17,18,19,20)
	(ii)	Type II H_0 will not be rejected	B1 B1 [2]	 or Stephan will conclude standard not fallen No contradictions
			[Total: 6]	

7	(i)	$\int_1^a \frac{k}{x}\,dx = 1$ $k[\ln x]_1^a = 1$ $k\ln a = 1 \quad k = 1/\ln a$	M1 A1 A1 [3]	Int f(x) & equate to 1. Ignore limits Correct integration and limits and = 1 AG
	(ii)	$\frac{1}{\ln a}\int_1^a 1\,dx$ or $k\int_1^a 1\,dx$ $= \frac{1}{\ln a}[x]_1^a$ or $k[x]_1^a$ $= \frac{1}{\ln a}(a-1)$	M1 A1 A1 [3]	Int xf(x). Ignore limits Correct integration and limits (condone missing k)
	(iii)	$\frac{1}{\ln a}\int_1^m \frac{1}{x}\,dx = 0.5$ $\frac{1}{\ln a}[\ln x]_1^m = 0.5$ $\frac{1}{\ln a}\ln m = 0.5$ $\ln m = 0.5\ln a$ $m = \sqrt{a}$	M1 A1 A1 A1 [4]	Int f(x) and equate to 0.5. Ignore limits Correct integration and limits (1 to m or m to a) (condone missing k) or $\ln m = \ln a^{0.5}$
			[Total: 10]	
8	(i)	V: cannot have neg value W: cannot have non-integer value	B1 B1 [2]	
	(ii)	(a) $e^{-\lambda} = p$ and $\lambda e^{-\lambda} = 2.5p$ (Hence $\lambda = 2.5$ **AG**)	B1 [1]	or equiv explanation
	(ii)	(b) $1 - e^{-2.5}(1 + 2.5 + \frac{2.5^2}{2})$ $= 0.456$ (3 sf)	M1 A1 [2]	Allow one end error
	(iii)	$\Phi^{-1}(0.5793) = -0.2$ N(μ, μ) seen or implied $\frac{40.5-\mu}{\sqrt{\mu}} = \text{“}-0.2\text{”}$ $\mu + \text{“}-0.2\text{”}\sqrt{\mu} - 40.5 = 0$ $\sqrt{\mu} = \frac{\text{"0.2"} \pm \sqrt{\text{"0.2"}^2 + 4\times 40.5}}{2}$ (= 6.4647..) $\mu = 41.8$ (3 sf)	B1 M1 M1 M1 A1 [5]	Allow no cc or incorrect cc For solving quadratic in $\sqrt{\mu}$ (or μ) Ignore other answer for $\sqrt{\mu}$, but not for μ
			[Total: 10]	

[Total for paper 50]