1	$e^{-4}(1+4)$ $= 0.0916$ (3 s.f.)	M1 M1 A1 [3]	M1 for P(0 or 1) using Poisson, any λ Expression of correct form correct λ (allow 1 end error) SR Use of Bin(100000, 1/25000) scores M1 for P(0,1) allow one end error. A1 0.0916
2	ht = $\frac{1}{2}$ seen $\frac{1}{2}\times m\times\left(\frac{m}{4}\times"\frac{1}{2}"\right)=\frac{1}{2}$ **N.B. B1 M1 must be consistent** $m=\sqrt{8}$ or $2\sqrt{2}$ or 2.83 (3 s.f.)	B1 M1 A1 [3]	or $y=\frac{1}{8}x$ $\frac{1}{2}\times m\times("\frac{1}{8}"m)=\frac{1}{2}$ or $\frac{m^2}{16}=\frac{1}{2}$ o.e. Or Integrating linear function of form $y = kx$ with limits 0 and m or m and 4 and equated to 0.5
3	$p = 0.56$ '0.56' $\pm z\times\sqrt{\frac{0.56\times0.44}{100}}$ $z = 2.17$, or 2.169 or 2.171 0.452 to 0.668 (3 s.f.)	B1 M1 B1 A1 [4]	Used Equation of correct form condone just +ve or –ve Must be z Seen Must be an interval
4	$\bar{x} = 1.65$ est$(\sigma^2)=\frac{100}{99}\left(\frac{276.25}{100}-1.65^2\right)$ $= 0.040404\ldots = 4/99$ $(\pm)\frac{1.65-1.6}{\sqrt{\frac{"0.040404"}{100}}}$ $= (\pm)$ 2.487/2.488 accept 2.49 Or 0.0065/0.0064 if area comparison done comp with 1.96 There is evidence that μ is not 1.6	B1 B1 M1 A1 M1 A1√ [6]	 Without $\frac{100}{99}$: $\frac{1.65-1.6}{\sqrt{\frac{"0.04"}{100}}}$ B1 B0 M1 $= 2.50$ A1 CV Method M1 must use 1.96 A1 for 1.639 or 1.6106 For valid comparison (z/z Signs consistent or area/area cv) Accept Reject H_0 No contradictions

5	**(i)**	Longest lifetime	B1 [1]	Must be in context
	(ii)	$\int_1^a \frac{k}{x^2}\,dx = 1$	M1	Int f(x) and equate to 1. Ignore limits
		$k\left[-\frac{1}{x}\right]_1^a = 1$	A1	Correct integral and limits
		$\left(k\left[-\frac{1}{a}+1\right]=1\right)$		
		$k\left[\frac{-1+a}{a}\right] = 1$ or $k(-1 + a) = a$		
		$k = \frac{a}{a-1}$ **AG**	A1 [3]	Must be convinced (**AG**)
	(iii)	$\frac{5}{3}\int_1^{2.5} \frac{1}{x}\,dx$ or $k\int_1^{2.5} \frac{1}{x}\,dx$	M1	Int xf(x). Ignore limits
		$= \frac{5}{3}[\ln x]_1^{2.5}$ or $k[\ln x]_1^{2.5}$	A1	Correct integral and limits (Accept "k" or "their k")
		$= \frac{5}{3}\ln 2.5$ or 1.53 (3 s.f.)	A1 [3]	
6	**(i)**	H_0: $p = 0.2$ H_1: $p < 0.2$	B1	(Allow π)
		P(0 or 1 5s in 25 | H_0)	M1	$0.8^{25} + 25 \times 0.8^{24} \times 0.2$ Use of B(25,1/5) and P(0) or P(1) or both – may be implied by "0.0274"
		= 0.0274 (3 s.f.)	A1	
		Comp with 0.025	M1	Valid comparison
		No evidence (at 2.5% level) to support claim	A1√ [5]	No contradictions **SR** Use of Normal N(5,4) leading to $z = 1.75$ or 0.0401 **B1*** H_0 $\mu = 5$ H_1 $\mu < 5$ B1. Comparison $1.75 < 1.96$ or $0.0401 > 0.025$ **B1* dep**
	(ii)	Normal	B1	
		$\mu = 200$, $\sigma^2 = 160$ or $\sigma = \sqrt{160}$	B1 [2]	
	(iii)	Concluding that the machine produces the right proportion of 5s, although it doesn't.	B1 [1]	Not concluding that the machine produces too few 5s although it does. Must be in context o.e. No contradictions

7 (i)	Constant mean (or average) rate	B1 [1]	Constant mean per day (or week, etc.) o.e.
(ii)	$e^{-\frac{4}{7}} \times \frac{\left(\frac{4}{7}\right)^2}{2!}$ or $e^{-0.571} \times \frac{0.571^2}{2!}$	M1	Expression for P(2) allow any λ
	= 0.0922 or 0.0921 (3 s.f.)	A1 [2]	
(iii)	$\lambda = \frac{40}{7}$ or 5.71…	B1	
	$1 - e^{-\frac{40}{7}}\left(1 + \frac{40}{7} + \frac{\left(\frac{40}{7}\right)^2}{2!} + \frac{\left(\frac{40}{7}\right)^3}{3!}\right)$	M1	Allow any λ allow one end error
	= 0.821 (3 s.f.)	A1 [3]	
(iv)	$\frac{24}{7}$ o.e. 3 s.f. or better seen	B1	
	$e^{-\frac{4}{7}} \times e^{-\frac{24}{7}} \times \frac{\left(\frac{24}{7}\right)^5}{5!}$	M1	M1 for P(0) × P(5) any consistent λ
	= 0.0723 (3 s.f.)	A1 [3]	
8 (i)	$X + 2.5Y \sim N(127, 44.25)$	B1 B1	B1 for 127 Allow at early stage (57 + 2.5 × 28) B1 for 44.25 or 6.65 Allow at early stage ($13 + 2.5^2 \times 5$) May be implied by next line
	$(\pm)\frac{140 - "127"}{\sqrt{"44.25"}}$	M1	For standardising
	= ±(1.954)	M1	For area consistent with their working
	1 – Φ("1.954")		
	= 0.0254/0.0253 (3 s.f.)	A1 [5]	
(ii)	$X - Y \sim N(29, 18)$	B1 B1	B1 for 29 Give at early stage (57 – 28) B1 for 18 Give at early stage (13 + 5) May be implied by next line
	$\frac{20 - "29"}{\sqrt{"18"}}$ (= –2.121)	M1	For Standardising
	1 – Φ("–2.121") = Φ("2.121")	M1	For area consistent with their working
	= 0.983 (3 s.f.)	A1 [5]	