Question	Scheme	Marks
2. (a)	$\mathrm{E}(T) = \int_0^4 \frac{1}{192} t(t^3 - 48t + 128)\,\mathrm{d}t$	M1
	$= \frac{1}{192}\left[\frac{t^5}{5} - 16t^3 + 64t^2\right]_0^4$ **or** $\left[\frac{t^5}{960} - \frac{1}{12}t^3 + \frac{1}{3}t^2\right]_0^4$ oe	dM1
	$= \frac{1}{192}\left(\frac{4^5}{5} - 16(4^3) + 64(4^2) - 0\right) = \frac{16}{15}\text{min} \rightarrow 1$ minute 4 seconds	A1
		(3)
(b)	P(call takes between 1 and 3 minutes) = $\int_1^3 \frac{1}{192}(t^3 - 48t + 128)\,\mathrm{d}t$	
	mor $\left[\frac{t^4}{768} - \frac{1}{8}t^2 + \frac{2}{3}t\right]_1^3$ oe	M1
	$= \frac{1}{192}\left(\left(\frac{3^4}{4} - 24(3^2) + 128(3)\right) - \left(\frac{1^4}{4} - 24(1^2) + 128(1)\right)\right) = \frac{7}{16}$ *	dM1 A1*cso
		(3)
(c)	$C \sim \mathrm{B}(256, \frac{7}{16}) \approx \mathrm{N}(112, 63)$	M1 A1
	$\mathrm{P}(C > 125) \approx \mathrm{P}\left(Z > \frac{125.5 - 112}{\sqrt{63}}\right)$	M1M1
	$\mathrm{P}(Z > 1.70) = 1 - 0.9554 = 0.0446$	A1
		(5)
	Notes	**[11 marks]**
(a)	1st M1 for using $\int t\mathrm{f}(t)\,\mathrm{d}t$ ignore limits. $t^4 \rightarrow t^5$ or $t^2 \rightarrow t^3$ or $t \rightarrow t^2$ for at least one term, ignore coefficients. Implied by an answer of $\frac{16}{15}$ or 1 minute 4 seconds (allow 64) or awrt 1.067	
	2nd dM1 dep on previous M1 fully correct integration with limit of 4 and 0 or 4 substituted (204.8) This mark is not implied by a correct answer	
	A1 the second M1 mark must be awarded 1 min 4 s (accept 64)	
	NB an answer of $\frac{16}{15}$ or 1 minute 4 seconds or 64 or awrt 1.067 with no working gains M1M0A0.	
(b)	1st M1 attempt to integrate $\int \mathrm{f}(t)\,\mathrm{d}t$ $t^n \rightarrow t^{n+1}$ for at least one term. Ignore limits. If they have integrated f(t) in part (a) and used this in part (b) we will allow this mark.	
	2nd M1 (dep on 1st M1) for use of correct limits. Must see substitution into their expression. If integration correct allow $\frac{1}{192}\left(\left(\frac{81}{4} - 216 + 384\right) - \left(\frac{1}{4} - 24 + 128\right)\right)$ or $\frac{1}{192}\left(\frac{753}{4} - \frac{417}{4}\right)$ or $\frac{251}{256} - \frac{139}{256}$	
	1st A1* cso $\frac{7}{16}[= 0.4375]$ fully correct solution (correct integration and substitution) . Answer is given so both method marks must be awarded.	
(c)	1st M1 use or sight of Normal approximation with mean 112	
	1st A1 correct mean and variance (condone 63^2 if used $\sqrt{63}$ in the standardisation)	
	2nd M1 standardising using their mean and variance. Allow use of 124.5, 125, 125.5, 126, 126.5 or on the numerator 12.5, 13, 13.5, 14, 14.5	
	3rd M1 use of continuity correction 125 ± 0.5 Implied by numerator of 12.5 or 13.5	
	2nd A1 awrt 0.0445/0.0446 [calc 0.0444865…]	
	[Exact binomial gives 0.0448518… and gains no marks]	