

Mark Scheme (Results)

October 2020

Pearson Edexcel International A Level in Statistics S2 (WST02/01)

Question Number		Scheme	Marks
1 (a)	$\int_{1}^{2} k \left(\frac{1}{2}x\right)^{2}$	$\int_{0}^{2} (x^{2} + ax + 1) dx = 1$	M1
	$k \left[\frac{1}{8} x^4 - \right]$	$-x^3 + \frac{1}{2}ax^2 + x \bigg]_1^2 [=1]$	A1
	k(2-8+	$+2a+2$) $-k$ $\left(\frac{1}{8}-1+\frac{1}{2}a+1\right)=1$ or $k(2a-4)-k\left(\frac{1}{8}+\frac{1}{2}a\right)=1$	dM1
	$-\frac{33}{8}k + \frac{1}{8}$	$\frac{3}{2}ka = 1$: $k(12a - 33) = 8*$	A1 *
			(4)
(b)		$k\left(\frac{3}{2}x^2 - 6x + a\right)$	M1
		$6x + 5 = 0$ or $\frac{4}{9}x^2 - \frac{16}{9}x + \frac{40}{27} = 0$	dM1
	$x = \frac{6 \pm 2}{3}$	$\frac{\sqrt{6^2 - 4 \times 1.5 \times 5}}{3}$	M1
	x = 2 -	$\frac{\sqrt{6}}{3}$ oe or 1.183 awrt 1.18	A1
			(4)
		Notes	Total 8
1(a)	M1	Attempting to integrate $f(x)$, (at least one term $x^n \to x^{n+1}$). Ignore limits. No Need to	_
	A1	Fully correct integration. Allow not simplified. Ignore limits and accept any letters. A No Need to equate to 1	
	dM1	Dep on 1 st M1. Subst in correct limits, subtracting results and equate to 1 Allow if th C the use of $F(2) = 1$ and $F(1) = 0$ to form 2 equations and solve to eliminate	+ <i>C</i>
	A1*	Answer is given. Correct solution only. At least one correct line of working required $k(2a-4)-k(\frac{1}{8}+\frac{1}{2}a)=1$ and the final given answer.	between
(b)	M1	Attempting to differentiate $f(x)$, (at least one term $x^n \to x^{n-1}$). Condone missing k or i value for k	ncorrect
	dM1	Dependent on first Method mark being awarded. Putting their differential (or multipl May be implied by awrt 1.18 or awrt 2.82	
	M1	Correct method for solving their 3 term quadratic equation. May be implied by awri	1.18 or
		awrt 2.82 Minimum for method if final answer is incorrect is of the form $\frac{6 \pm \sqrt{6}}{3}$	
	A1	Allow equivalent exact answer. awrt 1.18 Must eliminate the 2.816 or clearly indi	

Question Number		Scheme	Marks
2(a)	$f(w) = \begin{cases} \\ \end{cases}$	$ \frac{1}{8} -1.4 < w < 6.6 $ $ 0 $	M1 A1
(b)	E(W)=	2.6 oe	(2) B1 (1)
(c)	$(1.6-\alpha)$	$) \times "\frac{1}{8}" = 0.35$	M1
(0)		$\alpha = -1.2$ oe	A1cso (2)
(d)	P(1.2 <)	$W < 2.4$) = $(2.4 - 1.2) \times "\frac{1}{8}"$	M1
		$W < 2.4$) = $(2.4 - 1.2) \times "\frac{1}{8}"$ = $\frac{3}{20}$ or 0.15 oe	A1ft
			(2)
(e)	P(W > 2)	$2 \mid 1.2 < W < 2.4 = \frac{0.4 \times \frac{1}{8}}{0.15}$	M1
		$=\frac{1}{3}$ awrt 0.333	A1
(f)		dom variable Y is the number of days the train is between 1.2 minutes and 2.4 minutes $B(40, "0.15")$	(2) M1
	$P(Y \ge 10)$	$(1) = 1 - P(Y \le 9) \text{ or } 1 - 0.9328$	M1
		= 0.0672 awrt 0.0672	A1 (3)
		Notes	Total 12
2(a)	M1	pdf of the form $[f(w)] = \begin{cases} p & -1.4 < w < 6.6 \\ 0 & \text{otherwise} \end{cases}$ where p is a probability allow use of one/both $<$ signs. Allow equivale otherwise. Allow any letter/mix of p	ent for the 0
	A1	Fully correct allow use of \leq instead of one/both \leq signs. Allow any letter but must be α	
(b)	B1	2.6 oe	
(c)	M1	setting up equation $(1.6 - \alpha) \times$ "their p " = 0.35 with $0 or \frac{7}{20} = \frac{2.8}{8} and \alpha = 1.6 - 1.6 or F(1.6) - F(\alpha) = 0.35 using their F(w) in the form bw + c where 0 < b < 1. Allow for \int_{\alpha}^{1.6} "their f(w)" dw = 0.35 oe with an attempt to integrate (at least one term of the content of$	
	A1 cso	If using $F(1.6) - F(\alpha) = 0.35$ then $F(w)$ must be correct. Allow different letters	
(d)	M1	$(2.4-1.2)\times$ "their p " where "their $\frac{1}{8}$ " is a probability or $F(2.4) - F(1.2)$ using their $F(w)$ form $bw + c$ where $0 < b < 1$ Implied by 0.15 Allow for $\int_{1.2}^{2.4}$ "their $f(w)$ "dw with an attempt to integrate (at least one term correct).) in the
	A1ft	Ft their p as long as the answer is a probability	
(e)	M1	$\frac{0.4 \times \text{"their } \frac{1}{8}\text{"their } (d)\text{"}}{\text{"their } (d)\text{"}} \text{ or } \frac{0.4}{\text{"}1.2\text{"}} \text{ implied by } \frac{1}{3} \text{ Allow for } \int_{2}^{2.4} \text{"their } f(w)\text{"}dw \text{ with an attempt to } \frac{1}{3} \text{ and } $	o integrate
		(at least one term correct) for numerator	
	A1	Allow 0.3 or 0.33	
(f)	M1	Writing or using B(40, "their 0.15") Implied by mean of 40×"their (d)"	
	M1	Writing or using $1 - P(Y \le 9)$ Allow for $1 - P\left(z \le \frac{9.5 \text{ or } 9 - \text{"their mean"}}{\text{"their sd"}}\right)$	
	A1	awrt 0.0672	

Question Number		Scheme	Marks
3(a)(i)	<i>X</i> ~ B(1	0. 0.45)	M1
3(4)(1)	`	y = 0.0233 awrt 0.0233	A1
	$I(X \supseteq I)$	awit 0.0233	Al
(ii)	$P(X \ge 6$	$P(X) = 1 - P(X \le 5)$ or $1 - 0.7384$	M1
		= 0.2616 awrt 0.262	A1
	$F \sim N(54, 29.7)$ $\frac{c + 0.5 - 54}{\sqrt{29.7}} \le -1.6449 \text{or} \frac{d - 0.5 - 54}{\sqrt{29.7}} \ge 1.6449$ $c = 44 \text{ and } d = 64$ $H_0: p = 0.45 \qquad H_1: p < 0.45$ $Y \sim B(30, 0.45) \text{ therefore } P(Y \le 8) = 0.03 \text{ or } CR Y \le 8$	(4)	
(b)			M1A1
	$\frac{c+0.5-54}{6449} < -1.6449$ or $\frac{d-0.5-54}{6449} > 1.6449$		M1M1B1
	$\sqrt{29.7}$	$\sqrt{29.7}$	A1
	c = 44 ar	and $d=64$	Alcso
			(7)
(c)		1	B1
	$Y \sim B(30)$	$(0,0.45)$ therefore $P(Y \le 8) = 0.03$ or $CR Y \le 8$	B1
	8 is in th	e critical region or Reject H ₀ oe or significant	dM1
	therefore	the data collected supports the manufacturer's claim.	A1
			(4)
		Notes	Total 15
(a)(i)	M1	Writing or using B(10, 0.45) in (i) or (ii) implied by a correct answer to (i) or	(ii)
	A1	awrt 0.0233	
(ii)	M1	For writing or using $1 - P(X \le 5)$ oe	
	A1	awrt 0.262	
(b)	M1	For writing or using N(54,)	
(b)		For writing or using N(54,) For writing or using N(54, 29.7)	
(b)	M1 A1	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val	ue where
(b)	M1	For writing or using N(54,) For writing or using N(54, 29.7)	ue where
(b)	M1 A1	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5	
(b)	M1 A1 M1 M1	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val	= to z value
(b)	M1 A1 M1	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5 M1 for using a continuity correction ± 0.5 in standardisation. No need to put	= to z value
(b)	M1 A1 M1 M1	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5 M1 for using a continuity correction ± 0.5 in standardisation. No need to put = For using 1.6449 or better (calc gives) 1.64485 Allow if written then gone 0.1.65 or 1.64 or better in equation One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or	to z value on to use
(b)	M1 A1 M1 M1 B1	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5 M1 for using a continuity correction ± 0.5 in standardisation. No need to put = For using 1.6449 or better (calc gives) 1.64485 Allow if written then gone 0.65 or 1.64 or better in equation One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or All previous marks awarded. Both c and d correct integers	to z value on to use
	M1 A1 M1 M1 B1 A1 A1cso	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5 M1 for using a continuity correction ± 0.5 in standardisation. No need to put = For using 1.6449 or better (calc gives) 1.64485 Allow if written then gone 0.65 or 1.64 or better in equation One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or All previous marks awarded. Both c and d correct integers NB: c and d correct with no working can be awarded full marks	to z value on to use
(b)	M1 A1 M1 M1 B1 A1 A1cso	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5 M1 for using a continuity correction ± 0.5 in standardisation. No need to put = For using 1.6449 or better (calc gives) 1.64485 Allow if written then gone 0.1.65 or 1.64 or better in equation One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or All previous marks awarded. Both c and d correct integers NB: c and d correct with no working can be awarded full marks Both hypotheses correct in terms of p or π Must be attached to H ₀ and H ₁	= to z value on to use better
	M1 A1 M1 M1 B1 A1 A1cso	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5 M1 for using a continuity correction ± 0.5 in standardisation. No need to put a for using 1.6449 or better (calc gives) 1.64485 Allow if written then gone of 1.65 or 1.64 or better in equation One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or All previous marks awarded. Both c and d correct integers NB: c and d correct with no working can be awarded full marks Both hypotheses correct in terms of p or π Must be attached to H ₀ and H ₁ 0.03 or better (0.03120) or CR stated as $Y \le 8$ oe do not accept $P(Y \le 8) = 8$	= to z value on to use better
	M1 A1 M1 M1 B1 A1 A1cso B1 B1	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5 M1 for using a continuity correction ± 0.5 in standardisation. No need to put For using 1.6449 or better (calc gives) 1.64485 Allow if written then gone 0.1.65 or 1.64 or better in equation One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or All previous marks awarded. Both c and d correct integers NB: c and d correct with no working can be awarded full marks Both hypotheses correct in terms of p or p Must be attached to H ₀ and H ₁ 0.03 or better (0.03120) or CR stated as $Y \le 8$ oe do not accept $P(Y \le 8) = 8$. Condone 0.97 or better (0.96879)	= to z value on to use better
	M1 A1 M1 M1 B1 A1 A1cso	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5 M1 for using a continuity correction ± 0.5 in standardisation. No need to put = For using 1.6449 or better (calc gives) 1.64485 Allow if written then gone 0.65 or 1.64 or better in equation One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or All previous marks awarded. Both c and d correct integers NB: c and d correct with no working can be awarded full marks Both hypotheses correct in terms of p or p Must be attached to H ₀ and H ₁ 0.03 or better (0.03120) or CR stated as $Y \le 8$ oe do not accept $P(Y \le 8) = 0.00$. Condone 0.97 or better (0.96879) Dep on 2^{nd} B1 A correct statement – need not be contextual but do not allow	= to z value on to use better
	M1 A1 M1 M1 B1 A1 A1cso B1 B1	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5 M1 for using a continuity correction ± 0.5 in standardisation. No need to put = For using 1.6449 or better (calc gives) 1.64485 Allow if written then gone 0.65 or 1.64 or better in equation One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or All previous marks awarded. Both c and d correct integers NB: c and d correct with no working can be awarded full marks Both hypotheses correct in terms of p or π Must be attached to H ₀ and H ₁ 0.03 or better (0.03120) or CR stated as $Y \le 8$ oe do not accept $P(Y \le 8) = 0.00$. Condone 0.97 or better (0.96879) Dep on 2^{nd} B1 A correct statement – need not be contextual but do not allow contradicting non contextual comments.	= to z value on to use better
	M1 A1 M1 M1 B1 A1 A1cso B1 B1 dM1	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5 M1 for using a continuity correction \pm 0.5 in standardisation. No need to put = For using 1.6449 or better (calc gives) 1.64485 Allow if written then gone 0.1.65 or 1.64 or better in equation One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or All previous marks awarded. Both c and d correct integers NB: c and d correct with no working can be awarded full marks Both hypotheses correct in terms of p or π Must be attached to H ₀ and H ₁ 0.03 or better (0.03120) or CR stated as $Y \le 8$ oe do not accept $P(Y \le 8) = C$. Condone 0.97 or better (0.96879) Dep on 2^{nd} B1 A correct statement – need not be contextual but do not allow contradicting non contextual comments. Allow opposite conclusion if 2-tail hypotheses given.	= to z value on to use betterfor CR
	M1 A1 M1 M1 B1 A1 A1cso B1 B1	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5 M1 for using a continuity correction ± 0.5 in standardisation. No need to put For using 1.6449 or better (calc gives) 1.64485 Allow if written then gone 0.1.65 or 1.64 or better in equation One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or All previous marks awarded. Both c and d correct integers NB: c and d correct with no working can be awarded full marks Both hypotheses correct in terms of p or π Must be attached to H ₀ and H ₁ 0.03 or better (0.03120) or CR stated as $Y \le 8$ oe do not accept $P(Y \le 8) = 0.00$. Condone 0.97 or better (0.96879) Dep on 2^{nd} B1 A correct statement – need not be contextual but do not allow contradicting non contextual comments. Allow opposite conclusion if 2-tail hypotheses given. Correct conclusion for their H ₁ . If H ₁ is 2- tail the opposite conclusion must be	= to z value on to use betterfor CR
	M1 A1 M1 M1 B1 A1 A1cso B1 B1 dM1	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5 M1 for using a continuity correction ± 0.5 in standardisation. No need to put For using 1.6449 or better (calc gives) 1.64485 Allow if written then gone 1.65 or 1.64 or better in equation One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or All previous marks awarded. Both c and d correct integers NB: c and d correct with no working can be awarded full marks Both hypotheses correct in terms of p or π Must be attached to H ₀ and H ₁ 0.03 or better (0.03120) or CR stated as $Y \le 8$ oe do not accept $P(Y \le 8) = 10$. Condone 0.97 or better (0.96879) Dep on 2^{nd} B1 A correct statement – need not be contextual but do not allow contradicting non contextual comments. Allow opposite conclusion if 2-tail hypotheses given. Correct conclusion for their H ₁ . If H ₁ is 2- tail the opposite conclusion must be hypotheses or H ₁ $p > 0.45$ is A0. Allow belief instead of claim. Allow the date	to z value on to use better for CR e given. No
	M1 A1 M1 M1 B1 A1 A1cso B1 B1 dM1	For writing or using N(54,) For writing or using N(54, 29.7) For standardising (allow \pm) using their "54" and "29.7" and putting = to z val $1 < z < 2$ Condone missing ± 0.5 M1 for using a continuity correction ± 0.5 in standardisation. No need to put For using 1.6449 or better (calc gives) 1.64485 Allow if written then gone 0.1.65 or 1.64 or better in equation One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or All previous marks awarded. Both c and d correct integers NB: c and d correct with no working can be awarded full marks Both hypotheses correct in terms of p or π Must be attached to H ₀ and H ₁ 0.03 or better (0.03120) or CR stated as $Y \le 8$ oe do not accept $P(Y \le 8) = 0.00$. Condone 0.97 or better (0.96879) Dep on 2^{nd} B1 A correct statement – need not be contextual but do not allow contradicting non contextual comments. Allow opposite conclusion if 2-tail hypotheses given. Correct conclusion for their H ₁ . If H ₁ is 2- tail the opposite conclusion must be	to z value on to use better for CR e given. No

Question		Scheme	Mai	rks
Number				IKS
4(a)	Common	Spotted-orchids occur singly/randomly/independently	B1	(1)
(b)(i)	$S \sim \text{Po}(4$	5)		(1)
(0)(1)		$= \frac{e^{-4.5} \cdot 4.5^6}{6!} \text{ or } P(S \le 5) - P(S \le 5)$	M1	
	:	= 0.1281 awrt 0.128	A1	
(ii)	P(4 < S <	$(10) = P(S \le 9) - P(S \le 4)$ or $0.9829 - 0.5321$	M1	
		= 0.4508 awrt 0.451	A1	
	TT 4			(4)
(c)		$9 \text{ H}_1: \lambda > 9$	B1	
	$M \sim Po($	(9) $P(M \ge 11) = 1 - P(M \le 10)$ or $P(M \ge 15) = 0.0415$	M1	
		$= 0.294 \qquad \text{or } CR M \ge 15$	A1	
		or insignificant or 11 does not lie in the critical region	dM1	
	I nere is i	nsufficient evidence to support Juan's belief	A1	(5)
(d)	$T \sim N(90)$. 90)	B1	(3)
	`	$O(0) = P\left(Z < \pm \left(\frac{69.5 - 90}{\sqrt{90}}\right)\right) \text{ or } P(Z < \pm 2.160)$ awrt 2.16	M1	
		= 0.0154 awrt 0.0154	A1	
				(3)
(e)	$V \sim \text{Po}(20)$	00×0.012) = Po(2.4) $V \sim = Po(2.4)$	M1	
	P(V=0)	$+P(V=1)=e^{-2.4}(1+2.4)$	dM1	
	/	= 0.30844 awrt 0.308	A1	
				(3)
		Notes	Tot	al 16
4(a)	B1	One of the given reasons. No context needed		
(b)(i)	M1	For $\frac{e^{-\lambda}\lambda^{\circ}}{6!}$ with any value for λ or writing or using $P(S \le 6) - P(S \le 5)$		
		**		
(**)	A1	awrt 0.128		
(ii)	M1	awrt 0.128 Writing or using $P(S \le 9) - P(S \le 4)$		
	M1 A1	awrt 0.128 Writing or using $P(S \le 9) - P(S \le 4)$ awrt 0.451	1	
(ii) (c)	M1	awrt 0.128 Writing or using $P(S \le 9) - P(S \le 4)$ awrt 0.451 Both hypotheses correct. Must be attached to H_0 and H_1 in terms of λ or μ . Allow 4.5		
	M1 A1	awrt 0.128 Writing or using $P(S \le 9) - P(S \le 4)$ awrt 0.451 Both hypotheses correct. Must be attached to H_0 and H_1 in terms of λ or μ . Allow 4.55 Writing or using $Po(9)$ and $1 - P(M \le 10)$ or $P(M \ge 15) = 0.0415$ oe Implied by correct.		
	M1 A1 B1	awrt 0.128 Writing or using $P(S \le 9) - P(S \le 4)$ awrt 0.451 Both hypotheses correct. Must be attached to H_0 and H_1 in terms of λ or μ . Allow 4.5 is Writing or using $Po(9)$ and $1 - P(M \le 10)$ or $P(M \ge 15) = 0.0415$ oe Implied by correct awrt 0.3 or 0.29 or better (0.2940)		
	M1 A1 B1	awrt 0.128 Writing or using $P(S \le 9) - P(S \le 4)$ awrt 0.451 Both hypotheses correct. Must be attached to H_0 and H_1 in terms of λ or μ . Allow 4.5 in Writing or using $Po(9)$ and $1 - P(M \le 10)$ or $P(M \ge 15) = 0.0415$ on Implied by corrections or 0.29 or better (0.2940) 0.3 or 0.29 or better (0.2940)		
	M1 A1 B1 M1 A1	awrt 0.128 Writing or using $P(S \le 9) - P(S \le 4)$ awrt 0.451 Both hypotheses correct. Must be attached to H_0 and H_1 in terms of λ or μ . Allow 4.5 is Writing or using $P(S)$ and $1 - P(M \le 10)$ or $P(M \ge 15) = 0.0415$ oe Implied by corresponding to 0.3 or 0.29 or better (0.2940) 0.3 or 0.29 or better (0.2940) or $M \ge 15$ oe SC: Condone $P(X \le 10) = 0.7$ or better (0.705988) for M1A1	ect CR	
	M1 A1 B1 M1	awrt 0.128 Writing or using $P(S \le 9) - P(S \le 4)$ awrt 0.451 Both hypotheses correct. Must be attached to H_0 and H_1 in terms of λ or μ . Allow 4.5 is Writing or using $P(S) = 0.0415$ or $P(M \le 15) = 0.0415$ or Implied by corresponding to $P(S) = 0.0415$ or $P(S) = 0.04$	ect CR	
. ,	M1 A1 B1 M1 A1	awrt 0.128 Writing or using $P(S \le 9) - P(S \le 4)$ awrt 0.451 Both hypotheses correct. Must be attached to H_0 and H_1 in terms of λ or μ . Allow 4.5 is Writing or using $Po(9)$ and $1 - P(M \le 10)$ or $P(M \ge 15) = 0.0415$ oe Implied by corresponding to 0.3 or 0.29 or better (0.2940) 0.3 or 0.29 or better (0.2940) or $M \ge 15$ oe SC: Condone $P(X \le 10) = 0.7$ or better (0.705988) for M1A1 Dep on M1 A1. A correct statement—no context needed but do not allow contradicting contextual comments. Allow opposite conclusion if 2-tail hypotheses given.	ng non	or
	M1 A1 B1 M1 A1 A1 A1	awrt 0.128 Writing or using $P(S \le 9) - P(S \le 4)$ awrt 0.451 Both hypotheses correct. Must be attached to H_0 and H_1 in terms of λ or μ . Allow 4.5 in Writing or using $Po(9)$ and $1 - P(M \le 10)$ or $P(M \ge 15) = 0.0415$ on Implied by correct awrt 0.3 or 0.29 or better (0.2940) 0.3 or 0.29 or better (0.2940) or $M \ge 15$ on SC: Condone $P(X \le 10) = 0.7$ or better (0.705988) for M1A1 Dep on M1 A1. A correct statement—no context needed but do not allow contradicting contextual comments. Allow opposite conclusion if 2-tail hypotheses given. Correct conclusion. If H_0 is 2- tail the opposite conclusion must be given. No hypothese	ng non esses or]	or
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$ \begin{aligned} & S(a) & E(T^2) = \int_0^1 \frac{1}{50} (B u^2 - 2t^3) \mathrm{d}t + \int_0^1 \frac{1}{20} t^2 \mathrm{d}t \\ & = \left[\frac{1}{50} \left(6t^3 - \frac{t^4}{2} \right) \right]_0^3 + \left[\frac{t^2}{60} \right]_0^5 \mathrm{or} = \left[\frac{3}{25} t^3 - \frac{t^4}{100} \right]_0^3 + \left[\frac{t^2}{60} \right]_0^5 \mathrm{oe} \\ & = \frac{1}{50} \left(6x^3 - \frac{3}{2} \right) + \left(\frac{125}{60} - \frac{27}{60} \right) \mathrm{or} = \frac{1}{50} \left(162 - \frac{81}{81} \right) + \left(\frac{25}{12} - \frac{9}{20} \right) \mathrm{oe} \\ & = \frac{1219}{300} = 4.063 \dots \\ & Var(T) = \frac{4.063 \dots}{200} - \left(1.66 \right)^2 \\ & = 1.3077 \dots \\ & = 13.077 \dots$	Question Number		Scheme	Marks
$ = \frac{1}{50} \left(6 \times 3^3 - \frac{3^2}{2} \right) + \left(\frac{125}{60} - \frac{27}{60} \right) \text{ or } = \frac{1}{50} \left(162 - \frac{81}{2} \right) + \left(\frac{25}{22} - \frac{9}{20} \right) \text{ oe } $ M1d $ = \frac{1219}{300} = 4.063$ $Var(T) = {}^{4}.063^{-} (1.66)^{2} $ M1 $ = 1.3077 $ awrt 1.31 A1 $ = 1.3077 $ A1 $ = 1.3077 $ awrt 1.32 A1 $ = 1.3077 $ A1 $ = 1.3077 $ awrt 1.31 A1 $ = 1.3077 $ A1 $ = 1.3077 $ A2 $ = 1.3077 $ A1 $ = 1.3077 $ A2 $ = 1.3077 $ A1 $ = 1.3077 $ A2 $ = 1.3077 $ A1 $ = 1.3077 $ A1 $ = 1.3077 $ A2 $ = 1.3077 $ A3 $ = 1.3077 $ A2 $ = 1.3077 $ A2 $ = 1.3077 $ A2 $ = 1.3077 $ A3 $ = 1.3077 $ A2 $ = 1.3077 $ A3 $ = 1.3077 $ A2 $ = 1.3077 $ A3 $ = 1.3077 $ A2 $ = 1.3077 $ A3 $ = 1.3077 $ A4 $ = 1.3077 $ A1 $ = 1.3077 $	5(a)	$\mathrm{E}(T^2)$	$0 = \int_0^3 \frac{1}{50} \left(18t^2 - 2t^3 \right) dt + \int_3^5 \frac{1}{20} t^2 dt$	M1
			$= \left[\frac{1}{50} \left(6t^3 - \frac{t^4}{2}\right)\right]_0^3 + \left[\frac{t^3}{60}\right]_3^5 \text{ or } = \left[\frac{3}{25}t^3 - \frac{t^4}{100}\right]_0^3 + \left[\frac{t^3}{60}\right]_3^5 \text{ oe}$	A1
$Var(T) = "4.063" - (1.66)^2 = 1.3077 $			$= \frac{1}{50} \left(6 \times 3^3 - \frac{3^4}{2} \right) + \left(\frac{125}{60} - \frac{27}{60} \right) \text{ or } = \frac{1}{50} \left(162 - \frac{81}{2} \right) + \left(\frac{25}{12} - \frac{9}{20} \right) \text{ oe}$	M1d
$Var(T) = "4.063" - (1.66)^2 = 1.3077 $			$=\frac{1219}{300}=4.063$	
$ \begin{array}{c} = 1.3077 & \text{awrt 1.31} & \text{A1} \\ \hline (5) \\ \hline \\ \text{(b)} & \int_{1}^{t} \frac{1}{20} dx + C \text{ where } C = 0.9 \text{ or } \int_{0}^{3} \frac{1}{50} (18-2t) dt & \text{or using F(5)} = 1 \text{ to find } C \\ \hline \\$		Var(7		M1
(b) $ \int_{3}^{t} \frac{1}{20} dx + C \text{ where } C = 0.9 \text{ or } \int_{0}^{3} \frac{1}{50} (18 - 2t) dt \qquad \text{or using } F(5) = 1 \text{ to find } C $				A1
(b)		. 1	- 1	
	(b)	$\int_3^t \frac{1}{20} dx$	$c + C$ where $C = 0.9$ or $\int_0^3 \frac{1}{50} (18 - 2t) dt$ or using F(5) = 1 to find C	IMII
(c) $P(T>2)=1-\frac{1}{50}(18\times2-2^2)^n \text{ or } 1-\int_0^2\frac{1}{50}(18-2t) dt$ $=\frac{9}{25} \text{ or } 0.36$ $=0.933$ (a) $\frac{1}{1} \text{ Intention to find E}(T^2) \text{ correctly. They must add the 2 integrals and attempt to integrate (at least one term x^n \to x^{n+1}). Algebraic integration must be seen. Ignore limits. Allow as part of Var(T) condone Var(T) = (-1.66)^{2n} occurring twice. If no algebraic integration shown it is Var(T) = (-1.66)^{2n} occurring twice. If no algebraic integration shown it is Var(T) = (-1.66)^{2n} or Var($				B1
(c) $P(T>2)=1-\frac{1}{50}(18\times2-2^2)^n \text{ or } 1-\int_0^2\frac{1}{50}(18-2t) dt$ $=\frac{9}{25} \text{ or } 0.36$ $=0.933$ (a) $\frac{1}{1} \text{ Intention to find E}(T^2) \text{ correctly. They must add the 2 integrals and attempt to integrate (at least one term x^n \to x^{n+1}). Algebraic integration must be seen. Ignore limits. Allow as part of Var(T) condone Var(T) = (-1.66)^{2n} occurring twice. If no algebraic integration shown it is Var(T) = (-1.66)^{2n} occurring twice. If no algebraic integration shown it is Var(T) = (-1.66)^{2n} or Var($			$ \lceil F(t) = \rceil \begin{cases} \frac{1}{50} (18t - t^2) \text{ or } 1.62 - \frac{(18 - 2t)^2}{200} & 0 \le t \le 3 \end{cases} $	A1
(c) $P(T>2)=1-\frac{1}{50}(18\times2-2^2)^n \text{ or } 1-\int_0^2\frac{1}{50}(18-2t) dt$ $=\frac{9}{25} \text{ or } 0.36$ $=0.933$ (a) $\frac{1}{1} \text{ Intention to find E}(T^2) \text{ correctly. They must add the 2 integrals and attempt to integrate (at least one term x^n \to x^{n+1}). Algebraic integration must be seen. Ignore limits. Allow as part of Var(T) condone Var(T) = (-1.66)^{2n} occurring twice. If no algebraic integration shown it is Var(T) = (-1.66)^{2n} occurring twice. If no algebraic integration shown it is Var(T) = (-1.66)^{2n} or Var($			$\frac{1}{20}t + 0.75 3 < t \le 5$	A1
$= \frac{9}{25} \text{ or } 0.36$ $= \frac{9}{25} \text{ or } 0.366$ $= 0.933$ (a) M1 Intention to find $E(T^2)$ correctly. They must add the 2 integrals and attempt to integrate (at least one term $x^n \to x^{n+1}$). Algebraic integration must be seen. Ignore limits. Allow as part of $Var(T)$ condone " $-(1.66)^{2n}$ occurring twice. If no algebraic integration shown it is M0 A1 Correct integration M1d dep on previous M being awarded for correct limits and attempt to substitute. If no working shown An attempt may be implied by a correct answer or $1219/300$ or $243/100$ or $49/30$ oe M1 For their $E(T^2) - 1.66^2$ A1 awrt 1.31 Allow $2452/1875$ oe (b) M1 For a correct method to find the 3^{rd} line including limits unless using $F(5) = 1$ method. B1 2^{rd} line correct—any letter. Ignore missing inequality A1 3^{rd} line correct—any letter. Ignore missing inequality A1 3^{rd} line correct—any letter. Ignore missing inequality A1 Fully correct CDF All in terms of the same letter (Ignore LHS). Allow < instead of \le and vice versa. Allow "otherwise" for the range on the 1^{st} or last line but not both. (c) M1 For finding $1 - F(2)$ using their second line or starting again. Must subst in 2 A1 cao (d) M1 For realising they need $F(3.66)$ Allow $F(3.66)$ $F(0)$ allow $F(0)$ a			$\begin{array}{c c} & & & \\ & & 1 & & \\ & & & t > 5 \end{array}$	(4)
(d) P(0 < T < 3.66) = F(3.66)	(c)	P(T >	$(-2) = 1 - \frac{1}{50} (18 \times 2 - 2^2)$ " or $1 - \int_0^2 \frac{1}{50} (18 - 2t) dt$	M1
(d) P(0 < T < 3.66) = F(3.66) M1 = 0.933 A1 (2) Notes Total 13 (a) M1 Intention to find E(T²) correctly. They must add the 2 integrals and attempt to integrate (at least one term x ⁿ → x ⁿ⁺¹). Algebraic integration must be seen. Ignore limits. Allow as part of Var(T) condone " − (1.66)²" occurring twice. If no algebraic integration shown it is M0 A1 Correct integration M1d dep on previous M being awarded for correct limits and attempt to substitute. If no working shown An attempt may be implied by a correct answer or 1219/300 or 243/100 or 49\30 oe M1 For their E(T²) − 1.66² A1 awrt 1.31 Allow 2452/1875 oe (b) M1 For a correct method to find the 3 rd line including limits unless using F(5) = 1 method. B1 2 nd line correct – any letter. Ignore missing inequality A1 3 rd line correct—any letter. Ignore missing inequality A1 Fully correct CDF All in terms of the same letter (Ignore LHS). Allow < instead of ≤ and vice versa. Allow "otherwise" for the range on the 1 st or last line but not both. (c) M1 For finding 1 − F(2) using their second line or starting again. Must subst in 2 A1 cao (d) M1 For realising they need F(3.66) Allow F(3.66) [− F(0)] allow F("their mean +2") [− F(0)]			$=\frac{9}{25}$ or 0.36	A1
a Solution Solu		D(0	T. 2.60 F(2.60	
Notes Total 13 (a) M1 Intention to find E(T²) correctly. They must add the 2 integrals and attempt to integrate (at least one term x² → x²¹¹). Algebraic integration must be seen. Ignore limits. Allow as part of Var(T) condone " − (1.66)²" occurring twice. If no algebraic integration shown it is M0 A1 Correct integration M1d dep on previous M being awarded for correct limits and attempt to substitute. If no working shown An attempt may be implied by a correct answer or 1219/300 or 243/100 or 49\30 oe M1 For their E(T²) − 1.66² A1 awrt 1.31 Allow 2452/1875 oe (b) M1 For a correct method to find the 3rd line including limits unless using F(5) = 1 method. B1 2nd line correct — any letter. Ignore missing inequality A1 3rd line correct — any letter. Ignore missing inequality A1 Fully correct CDF All in terms of the same letter (Ignore LHS). Allow < instead of ≤ and vice versa. Allow "otherwise" for the range on the 1st or last line but not both. (c) M1 For finding 1 – F(2) using their second line or starting again. Must subst in 2 A1 cao (d) M1 For realising they need F(3.66) Allow F(3.66) [- F(0)] allow F("their mean +2") [- F(0)]	(d)	P(0 <	· · · · · ·	
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 A1 Correct integration M1d dep on previous M being awarded for correct limits and attempt to substitute. If no working shown An attempt may be implied by a correct answer or 1219/300 or 243/100 or 49\30 oe M1 For their E(T²) - 1.66² A1 awrt 1.31 Allow 2452/1875 oe (b) M1 For a correct method to find the 3rd line including limits unless using F(5) = 1 method. B1 2nd line correct – any letter. Ignore missing inequality A1 3rd line correct – any letter. Ignore missing inequality A1 Fully correct CDF All in terms of the same letter (Ignore LHS). Allow < instead of ≤ and vice versa. Allow "otherwise" for the range on the 1st or last line but not both. (c) M1 For finding 1 – F(2) using their second line or starting again. Must subst in 2 A1 cao (d) M1 For realising they need F(3.66) Allow F(3.66) [- F(0)] allow F("their mean +2") [- F(0)] 			one term $x^n \to x^{n+1}$). Algebraic integration must be seen. Ignore limits. Allow as part of	Var(T)
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	(d)	1]
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Question Number		Scheme	Marks
6(a)	<u>probabi</u>	ing distribution is <u>all</u> the <u>values</u> of a <u>statistic</u> and the associated <u>lities</u> robability distribution of the <u>statistic</u> .	B1
			(1)
(b)		(40)) = 0.5, $P(medium(80)) = 0.3$, $P(large(150)) = 0.2$	B1
	Range (I	R) 0, 40, 70, 110	B1
	[P(R=0)]	$0) =]"0.5"^3 + "0.3"^3 + "0.2"^3 = 0.16$	M1
	(80,80,1	0) (40,80,80) 50) (80,150,150) 50) (40,80,150) (40,150,150)	B1
		$40) = 3 \times (0.5 \times 0.3)^{2} + 3 \times (0.5 \times 0.3)^{2} + 3 \times (0.5 \times 0.3)^{2}$	
	P(R =	$70) = 3 \times (0.3^{2} \times 0.2) + 3 \times (0.3^{2} \times 0.2) = 0.09$	M1 M1
	P(R=1)	$10) =]3 \times ("0.5"^2 \times "0.2") + 3 \times ("0.5" + "0.2"^2) + 6 \times ("0.5" \times "0.3" \times "0.2") = 0.39$	
	R	0 40 70 110 0.16 0.36 0.09 0.39	Alcao
		0.10 0.50 0.07 0.57	(7)
(c)	(1-"0.0	$9")^n < 0.2$ or $("0.91")^n < 0.2$	M1
	n > 17.	, , ,	M1
	n=18		Al
	n-10)	(3)
		Notes	Total 11
6(a)	B1	A correct explanation with the words in bold. Allow equivalent words eg out	
(1.)	D1	values	1 1 111
(b)	B 1	Correct probabilities – may be seen in an equation or implied by a correct pro-	bability
	D1	for $R = 0$ or for 2 correct probabilities from those for $R = 40$, $R = 70$, $R = 110$	
	B1 M1	All four ranges correct with no extra. Correct method for finding $P(R = 0)$	
	IVII	All the correct combinations for $R = 40$, 70 and 110. $R = 0$ combinations are no	ot
		required but no incorrect combinations must be seen (may use bag size rather	
	B1	numbers in bag) May be implied by a correct probability for $P(R = 40)$, $P(R = 40)$	
	D1	P(R = 110) or by correct working seen for each of the 7 combinations (no need	
		number of ways of arranging ie $3 \times$ or $6 \times$) eg $(40,40,80) = 0.5^2 \times 0.3$	
	M1	Correct method for one of the probabilities for $P(R = 40)$, $P(R = 70)$, $P(R = 11)$	0)
		Correct method for a second probability for $P(R = 40)$, $P(R = 70)$, $P(R = 110)$	
	M1	probabilities add up to 1.	
	A1	Correct answer only. Allow answers as a fraction. Need not be in a table but	
		probabilities must be attached to the correct range	
(c)	M1	Setting up a correct inequality using their 0.09 Allow written as an equation.	
		For 17.1 or better allow $\frac{\log 0.2}{\log"0.91"}$ or $\log_{"0.91"}0.2$ oe If inequality/equation is	incorrect
	M1		
		but of the form $(p)^n < 0.2$ $(p)^n = 0.2$ where $0 this mark can be award$	acu II
		but of the form $(p)^n < 0.2$ $(p)^n = 0.2$ where $0 this mark can be award working is shown$	ieu II
	A1	but of the form $(p)^n < 0.2$ $(p)^n = 0.2$ where $0 this mark can be award working is shown 18 do not accept n > 18 or n < 18 if final answer$	ieu II