



# Mark Scheme (Results)

October 2020

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

Question Number	Scheme		Marks
1 (a)	$\int_1^2 k \left( \frac{1}{2}x^3 - 3x^2 + ax + 1 \right) dx [=1]$		M1
	$k \left[ \frac{1}{8}x^4 - x^3 + \frac{1}{2}ax^2 + x \right]_1^2 [=1]$		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
	$-\frac{33}{8}k + \frac{3}{2}ka = 1 \therefore k(12a-33) = 8^*$		A1 *
			(4)
(b)	$\frac{df(x)}{dx} = k \left( \frac{3}{2}x^2 - 6x + a \right)$		M1
	$\frac{3}{2}x^2 - 6x + 5 = 0$ or $\frac{4}{9}x^2 - \frac{16}{9}x + \frac{40}{27} = 0$		dM1
	$x = \frac{6 \pm \sqrt{6^2 - 4 \times 1.5 \times 5}}{3}$		M1
	$x = 2 - \frac{\sqrt{6}}{3}$ oe or 1.183...		awrt 1.18 A1
			(4)
<b>Notes</b>			<b>Total 8</b>
1(a)	<b>M1</b>	Attempting to integrate f(x), (at least one term $x^n \rightarrow x^{n+1}$ ). Ignore limits. No Need to equate to 1	
	<b>A1</b>	Fully correct integration. Allow not simplified. Ignore limits and accept any letters. Allow + C No Need to equate to 1	
	<b>dM1</b>	Dep on 1 <sup>st</sup> M1. Subst in correct limits, subtracting results and equate to 1 Allow if they have + C the use of F(2) = 1 and F(1) = 0 to form 2 equations and solve to eliminate + C	
	<b>A1*</b>	Answer is given. Correct solution only. At least one correct line of working required between $k(2a-4) - k\left(\frac{1}{8} + \frac{1}{2}a\right) = 1$ and the final given answer.	
(b)	<b>M1</b>	Attempting to differentiate f(x), (at least one term $x^n \rightarrow x^{n-1}$ ). Condone missing k or incorrect value for k	
	<b>dM1</b>	Dependent on first Method mark being awarded. Putting their differential (or multiple of) = 0 May be implied by awrt 1.18 or awrt 2.82	
	<b>M1</b>	Correct method for solving their 3 term quadratic equation. May be implied by awrt 1.18 or awrt 2.82 Minimum for method if final answer is incorrect is of the form $\frac{6 \pm \sqrt{6}}{3}$	
	<b>A1</b>	Allow equivalent exact answer. awrt 1.18 Must eliminate the 2.816... or clearly indicate which of the 2 solutions is their answer	

Question Number	Scheme		Marks
2(a)	$f(w) = \begin{cases} \frac{1}{8} & -1.4 < w < 6.6 \\ 0 & \text{otherwise} \end{cases}$		M1 A1 (2)
(b)	E(W) = 2.6 oe		B1 (1)
(c)	$(1.6 - \alpha) \times \frac{1}{8} = 0.35$ $\alpha = -1.2 \text{ oe}$		M1 A1cso (2)
(d)	$P(1.2 < W < 2.4) = (2.4 - 1.2) \times \frac{1}{8}$ $= \frac{3}{20} \text{ or } 0.15 \text{ oe}$		M1 A1ft (2)
(e)	$P(W > 2 \mid 1.2 < W < 2.4) = \frac{0.4 \times \frac{1}{8}}{0.15}$ $= \frac{1}{3} \quad \text{awrt } 0.333$		M1 A1 (2)
(f)	The random variable Y is the number of days the train is between 1.2 minutes and 2.4 minutes late $Y \sim B(40, "0.15")$		M1
	P(Y ≥ 10) = 1 - P(Y ≤ 9) or 1 - 0.9328		M1
	= 0.0672 awrt 0.0672		A1 (3)
<b>Notes</b>			<b>Total 12</b>
2(a)	<b>M1</b>	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 ≤ instead of one/both < signs. Allow equivalent for the 0 otherwise. Allow any letter/mix of letters
	<b>A1</b>	Fully correct allow use of ≤ instead of one/both < signs. Allow any letter but must be consistent.	
(b)	<b>B1</b>	2.6 oe	
(c)	<b>M1</b>	setting up equation $(1.6 - \alpha) \times \text{"their } p\text{"} = 0.35$ with $0 < p < 1$ or $\frac{7}{20} = \frac{2.8}{8}$ and $\alpha = 1.6 - \text{"2.8"}$ or $F(1.6) - F(\alpha) = 0.35$ using their F(w) in the form $bw + c$ where $0 < b < 1$ Allow for $\int_{\alpha}^{1.6} \text{"their } f(w)\text{"} dw = 0.35$ oe with an attempt to integrate (at least one term correct).	
	<b>A1 cso</b>	If using $F(1.6) - F(\alpha) = 0.35$ then F(w) must be correct. Allow different letters	
(d)	<b>M1</b>	$(2.4 - 1.2) \times \text{"their } p\text{"}$ where $\text{"their } \frac{1}{8}\text{"}$ is a probability or $F(2.4) - F(1.2)$ using their F(w) in the form $bw + c$ where $0 < b < 1$ Implied by 0.15 Allow for $\int_{1.2}^{2.4} \text{"their } f(w)\text{"} dw$ with an attempt to integrate (at least one term correct).	
	<b>A1ft</b>	Ft their p as long as the answer is a probability	
(e)	<b>M1</b>	$\frac{0.4 \times \text{"their } \frac{1}{8}\text{"}}{\text{"their (d)"}}$ or $\frac{0.4}{\text{"1.2"}}$ implied by $\frac{1}{3}$ Allow for $\int_2^{2.4} \text{"their } f(w)\text{"} dw$ with an attempt to integrate (at least one term correct) for numerator	
	<b>A1</b>	Allow 0.3̇ or 0.33̇	
(f)	<b>M1</b>	Writing or using B(40, "their 0.15") Implied by mean of $40 \times \text{"their (d)"}$	
	<b>M1</b>	Writing or using $1 - P(Y \leq 9)$ Allow for $1 - P\left(z \leq \frac{9.5 \text{ or } 9 - \text{"their mean"}}{\text{"their sd"}}\right)$	
	<b>A1</b>	awrt 0.0672	

Question Number	Scheme		Marks
3(a)(i)	$X \sim B(10, 0.45)$		M1
	$P(X \leq 1) = 0.0233$	awrt 0.0233	A1
(ii)	$P(X \geq 6) = 1 - P(X \leq 5)$ or $1 - 0.7384$		M1
	$= 0.2616\dots$	awrt 0.262	A1
			(4)
(b)	$F \sim N(54, 29.7)$		M1A1
	$\frac{c + 0.5 - 54}{\sqrt{29.7}} \leq -1.6449$	or $\frac{d - 0.5 - 54}{\sqrt{29.7}} \geq 1.6449$	M1M1B1 A1
	$c = 44$ and $d = 64$		A1cso
			(7)
(c)	$H_0: p = 0.45$ $H_1: p < 0.45$		B1
	$Y \sim B(30, 0.45)$ therefore $P(Y \leq 8) = 0.03\dots$ or CR $Y \leq 8$		B1
	8 is in the critical region or Reject $H_0$ oe or significant		dM1
	therefore the data collected supports the <b>manufacturer's claim.</b>		A1
			(4)
<b>Notes</b>			<b>Total 15</b>
(a)(i)	<b>M1</b>	Writing or using $B(10, 0.45)$ in (i) or (ii) implied by a correct answer to (i) or (ii)	
	<b>A1</b>	awrt 0.0233	
(ii)	<b>M1</b>	For writing or using $1 - P(X \leq 5)$ oe	
	<b>A1</b>	awrt 0.262	
(b)	<b>M1</b>	For writing or using $N(54, \dots)$	
	<b>A1</b>	For writing or using $N(54, 29.7)$	
	<b>M1</b>	For standardising (allow $\pm$ ) using their "54" and "29.7" and putting = to z value where $1 <  z  < 2$ Condone missing $\pm 0.5$	
	<b>M1</b>	M1 for using a continuity correction $\pm 0.5$ in standardisation. No need to put = to z value	
	<b>B1</b>	For using 1.6449 or better (calc gives) 1.64485... Allow if written then gone on to use 1.65 or 1.64 or better in equation	
	<b>A1</b>	One correct inequality. Allow written as an equation. Allow with 1.65/1.64 or better	
	<b>A1cso</b>	All previous marks awarded. Both $c$ and $d$ correct integers	
		NB: $c$ and $d$ correct with no working can be awarded full marks	
(c)	<b>B1</b>	Both hypotheses correct in terms of $p$ or $\pi$ Must be attached to $H_0$ and $H_1$	
	<b>B1</b>	0.03 or better (0.03120...) or CR stated as $Y \leq 8$ oe do not accept $P(Y \leq 8) = \dots$ for CR Condone 0.97 or better (0.96879...)	
	<b>dM1</b>	Dep on 2 <sup>nd</sup> B1 A correct statement – need not be contextual but do not allow contradicting non contextual comments. Allow opposite conclusion if 2-tail hypotheses given.	
	<b>A1</b>	Correct conclusion for their $H_1$ . If $H_1$ is 2-tail the opposite conclusion must be given. No hypotheses or $H_1 p > 0.45$ is A0. Allow belief instead of claim. Allow the data collected supports that the <b>proportion/percentage/probability/number/amount</b> oe of flawed <b>plates</b> has <b>decreased/reduced/is not 0.45/has changed</b> oe	

Question Number	Scheme		Marks
4(a)	Common Spotted-orchids occur singly/randomly/independently		B1
			(1)
(b)(i)	$S \sim \text{Po}(4.5)$		
	$P(S = 6) = \frac{e^{-4.5} 4.5^6}{6!}$ or $P(S \leq 6) - P(S \leq 5)$		M1
	$= 0.1281\dots$		awrt 0.128 A1
(ii)	$P(4 < S < 10) = P(S \leq 9) - P(S \leq 4)$ or $0.9829 - 0.5321$		M1
	$= 0.4508$		awrt 0.451 A1
			(4)
(c)	$H_0 : \lambda = 9 \quad H_1 : \lambda > 9$		B1
	$M \sim \text{Po}(9) \quad P(M \geq 11) = 1 - P(M \leq 10)$ or $P(M \geq 15) = 0.0415$		M1
	$= 0.294$ or CR $M \geq 15$		A1
	Accept $H_0$ or insignificant or 11 does not lie in the critical region		dM1
	There is insufficient evidence to support <b>Juan's belief</b>		A1
			(5)
(d)	$T \sim N(90, 90)$		B1
	$P(T < 70) = P\left(Z < \pm \left(\frac{69.5 - 90}{\sqrt{90}}\right)\right)$ or $P(Z < \pm 2.160\dots\dots)$		awrt 2.16 M1
	$= 0.0154$		awrt 0.0154 A1
			(3)
(e)	$V \sim \text{Po}(200 \times 0.012) = \text{Po}(2.4) \quad V \sim = \text{Po}(2.4)$		M1
	$P(V = 0) + P(V = 1) = e^{-2.4}(1 + 2.4)$		dM1
	$= 0.30844\dots$		awrt 0.308 A1
			(3)
<b>Notes</b>			<b>Total 16</b>
4(a)	<b>B1</b>	One of the given reasons. No context needed	
(b)(i)	<b>M1</b>	For $\frac{e^{-\lambda} \lambda^6}{6!}$ with any value for $\lambda$ or writing or using $P(S \leq 6) - P(S \leq 5)$	
	<b>A1</b>	awrt 0.128	
(ii)	<b>M1</b>	Writing or using $P(S \leq 9) - P(S \leq 4)$	
	<b>A1</b>	awrt 0.451	
(c)	<b>B1</b>	Both hypotheses correct. Must be attached to $H_0$ and $H_1$ in terms of $\lambda$ or $\mu$ . Allow 4.5 instead of 9.	
	<b>M1</b>	Writing or using $\text{Po}(9)$ and $1 - P(M \leq 10)$ or $P(M \geq 15) = 0.0415$ oe Implied by correct CR or awrt 0.3 or 0.29... or better (0.2940...)	
	<b>A1</b>	0.3 or 0.29... or better (0.2940...) or $M \geq 15$ oe SC: Condone $P(X \leq 10) = 0.7$ or better (0.705988....) for M1A1	
	<b>dM1</b>	Dep on M1 A1. A correct statement– no context needed but do not allow contradicting non contextual comments. Allow opposite conclusion if 2-tail hypotheses given.	
	<b>A1</b>	Correct conclusion. If $H_0$ is 2- tail the opposite conclusion must be given. No hypotheses or $H_0 \lambda < 9$ gets A0. Allow claim instead of belief. Alternative: There is insufficient evidence to support hat the number of Common Spotted-orchids has <b>increased/ /is not 9/has changed oe</b> (with the bold words included).	
(d)	<b>B1</b>	Writing or using $N(90, 90)$	
	<b>M1</b>	Standardising with 68.5 or 69.5 or 70.5 and their mean and sd	
	<b>A1</b>	awrt 0.0154 <b>NB</b> Poisson gives 0.01275...	
(e)	<b>M1</b>	Writing or using $\text{Po}(200 \times 0.012)$ Allow $\text{Po}(200 \times \text{"their d"})$	
	<b>dM1</b>	Dependent on using Poisson. For using / writing $P(V = 0) + P(V = 1)$ or $e^{-\lambda}(1 + \lambda)$ or $P(V \leq 1)$ oe	
	<b>A1</b>	awrt 0.308 <b>NB</b> Binomial gives 0.3066	

Question Number	Scheme		Marks
5(a)	$E(T^2) = \int_0^3 \frac{1}{50}(18t^2 - 2t^3) dt + \int_3^5 \frac{1}{20}t^2 dt$		M1
	$= \left[ \frac{1}{50} \left( 6t^3 - \frac{t^4}{2} \right) \right]_0^3 + \left[ \frac{t^3}{60} \right]_3^5$ or $= \left[ \frac{3}{25}t^3 - \frac{t^4}{100} \right]_0^3 + \left[ \frac{t^3}{60} \right]_3^5$ oe		A1
	$= \frac{1}{50} \left( 6 \times 3^3 - \frac{3^4}{2} \right) + \left( \frac{125}{60} - \frac{27}{60} \right)$ or $= \frac{1}{50} \left( 162 - \frac{81}{2} \right) + \left( \frac{25}{12} - \frac{9}{20} \right)$ oe		M1d
	$= \frac{1219}{300} = 4.063\dots$		
	$\text{Var}(T) = "4.063\dots" - (1.66)^2$		M1
	$= 1.3077\dots$		awrt 1.31 A1
			(5)
(b)	$\int_3^t \frac{1}{20} dx + C$ where $C = 0.9$ or $\int_0^3 \frac{1}{50}(18-2t) dt$ or using $F(5) = 1$ to find $C$		M1
	$[F(t) = ] \begin{cases} 0 & t < 0 \\ \frac{1}{50}(18t - t^2) \text{ or } 1.62 - \frac{(18-2t)^2}{200} & 0 \leq t \leq 3 \\ \frac{1}{20}t + 0.75 & 3 < t \leq 5 \\ 1 & t > 5 \end{cases}$		B1
			A1
			A1
			(4)
(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
	$= \frac{9}{25}$ or 0.36		A1
(d)	$P(0 < T < 3.66) = F(3.66)$		M1
	$= 0.933$		A1
<b>Notes</b>			<b>Total 13</b>
(a)	<b>M1</b>	Intention to find $E(T^2)$ correctly. They must add the 2 integrals and attempt to integrate (at least one term $x^n \rightarrow x^{n+1}$ ). Algebraic integration must be seen. Ignore limits. Allow as part of $\text{Var}(T)$ condone $" - (1.66)^2 "$ occurring twice. If no algebraic integration shown it is M0	
	<b>A1</b>	Correct integration	
	<b>M1d</b>	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	
	<b>M1</b>	For their $E(T^2) - 1.66^2$	
	<b>A1</b>	awrt 1.31 Allow 2452 / 1875 oe	
(b)	<b>M1</b>	For a correct method to find the 3 <sup>rd</sup> line including limits unless using $F(5) = 1$ method.	
	<b>B1</b>	2 <sup>nd</sup> line correct – any letter. Ignore missing inequality	
	<b>A1</b>	3 <sup>rd</sup> line correct– any letter. Ignore missing inequality	
	<b>A1</b>	Fully correct CDF All in terms of the same letter (Ignore LHS). Allow $<$ instead of $\leq$ and vice versa. Allow "otherwise" for the range on the 1 <sup>st</sup> or last line but not both.	
(c)	<b>M1</b>	For finding $1 - F(2)$ using their second line or starting again. Must subst in 2	
	<b>A1</b>	cao	
(d)	<b>M1</b>	For realising they need $F(3.66)$ Allow $F(3.66) [- F(0)]$ allow $F("their\ mean + 2") [- F(0)]$	
	<b>A1</b>	Cao allow answer as a fraction	

Question Number	Scheme				Marks	
6(a)	A sampling distribution is <b>all</b> the <b>values</b> of a <b>statistic</b> and the associated <b>probabilities</b> or the <b>probability distribution</b> of the <b>statistic</b> .				B1 (1)	
(b)	P(small(40)) = 0.5, P(medium(80)) = 0.3, P(large(150)) = 0.2				B1	
	Range (R) 0, 40, 70, 110				B1	
	$[P(R=0) = ]0.5^3 + 0.3^3 + 0.2^3 = 0.16$				M1	
	(40,40,80) (40,80,80) (80,80,150) (80,150,150) (40,40,150) (40,80,150) (40,150,150)				B1	
	$[P(R=40) = ]3 \times (0.5 \times 0.3^2) + 3 \times (0.5^2 \times 0.3)$				M1 M1	
	$[P(R=70) = ]3 \times (0.3^2 \times 0.2) + 3 \times (0.3 \times 0.2^2) = 0.09$					
	$[P(R=110) = ]3 \times (0.5^2 \times 0.2) + 3 \times (0.5 \times 0.2^2) + 6 \times (0.5 \times 0.3 \times 0.2) = 0.39$					
	R	0	40	70	110	A1cao
	r	0.16	0.36	0.09	0.39	
					(7)	
(c)	$(1 - 0.09)^n < 0.2$ or $(0.91)^n < 0.2$				M1	
	$[n > ]17.065...$				M1	
	$n = 18$				A1	
					(3)	
<b>Notes</b>					<b>Total 11</b>	
6(a)	<b>B1</b>	A correct explanation with the words in bold. Allow equivalent words eg outcomes for values				
(b)	<b>B1</b>	Correct probabilities – may be seen in an equation or implied by a correct probability for $R = 0$ or for 2 correct probabilities from those for $R = 40, R = 70, R = 110$				
	<b>B1</b>	All four ranges correct with no extra.				
	<b>M1</b>	Correct method for finding $P(R = 0)$				
	<b>B1</b>	All the correct combinations for $R = 40, 70$ and $110$ . $R = 0$ combinations are not required but no incorrect combinations must be seen (may use bag size rather than numbers in bag) May be implied by a correct probability for $P(R = 40), P(R = 70)$ and $P(R = 110)$ or by correct working seen for each of the 7 combinations (no need for the number of ways of arranging ie $3 \times$ or $6 \times$ ) eg $(40,40,80) = 0.5^2 \times 0.3$				
	<b>M1</b>	Correct method for one of the probabilities for $P(R = 40), P(R = 70), P(R = 110)$				
	<b>M1</b>	Correct method for a second probability for $P(R = 40), P(R = 70), P(R = 110)$ or the 4 probabilities add up to 1.				
	<b>A1</b>	Correct answer only. Allow answers as a fraction. Need not be in a table but probabilities must be attached to the correct range				
(c)	<b>M1</b>	Setting up a correct inequality using their 0.09 Allow written as an equation.				
	<b>M1</b>	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 but of the form $(p)^n < 0.2$ $(p)^n = 0.2$ where $0 < p < 1$ this mark can be awarded if working is shown				
	<b>A1</b>	18 do not accept $n > 18$ or $n < 18$ if final answer				