

FS1Ch2 XMQs and MS

(Total: 108 marks)

1. FS1_2019 Q2 . 8 marks - FS1ch2 Poisson distributions
2. FS1_2020 Q1 . 13 marks - FS1ch2 Poisson distributions
3. FS1_2020 Q2 . 4 marks - FS1ch2 Poisson distributions
4. FS1_2021 Q2 . 14 marks - FS1ch2 Poisson distributions
5. FS1_2021 Q4 . 10 marks - FS1ch1 Discrete random variables
6. FS1_2022 Q3 . 14 marks - FS1ch2 Poisson distributions
7. FS1_2023 Q2 . 11 marks - FS1ch2 Poisson distributions
8. FS1_2024 Q2 . 7 marks - FS1ch2 Poisson distributions
9. FS1_Sample Q1 . 5 marks - FS1ch2 Poisson distributions
10. FS1_Sample Q2 . 12 marks - FS1ch2 Poisson distributions
11. FS1_Specimen Q3 . 10 marks - FS1ch2 Poisson distributions

Qu	Scheme	Marks	AO
2(a)	{Let C = no of calls in a 20 min period} $C \sim \text{Po}(\dots)$	M1	3.3
	80 calls per 4-hour period gives $\frac{20}{3}$ per 20 mins i.e. $C \sim \text{Po}(\frac{20}{3})$	M1	3.4
	$[P(C > 4)] = 1 - P(C \leq 4)$ $= 0.79437\dots$ awrt 0.794	A1 (3)	1.1b
(b)	{ X = no. of 5 min periods with no calls } $X \sim B(4, e^{-\frac{5}{3}})$	M1	3.3
	$P(X = 3) = 0.02186125\dots$ awrt 0.0219	A1 (2)	1.1b
(c)	P(exactly one call) $e^{-\frac{5}{3}} \times \frac{5}{3}$ or $e^{-5} \times 5$	M1	2.1
	P(exactly one call in each break) = $\left(e^{-\frac{5}{3}} \times \frac{5}{3} \right) \times (e^{-5} \times 5)$	M1	1.1b
	$= 0.0106052\dots$ awrt 0.0106	A1 (3)	1.1b
Notes			
(a)	1 st M1 for selecting a Poisson model – written or used. May be implied by 2 nd M1 or a correct Answer.		
	2 nd M1 for the correct Poisson $\text{Po}(\frac{20}{3})$ or $\text{Po}(6.67)$ or better seen <u>and</u> writing or using $1 - P(C \leq 4)$		
	A1 for awrt 0.794 (correct ans with no incorrect working scores 3/3)		
(b)	M1 for selecting a correct model $B(4, 0.189)$ or better (calc: 0.188875...)		
	A1 for using the model to get awrt 0.0219 (correct ans with no incorrect working scores 2/2)		
(c)	1 st M1 for a correct prob of 1 call (expressions in e or values) (allow 0.31479... or awrt 0.315 or 0.033689... or awrt 0.0337)		
	2 nd M1 for a correct probability statement or expression. E.g. $P(S = 1 S \sim \text{Po}(\frac{5}{3})) \times P(T = 1 T \sim \text{Po}(5))$		
SC	e.g. $F \sim \text{Po}(\lambda)$ used in (b) to find $P(F = 0)$ Then if we see $Y \sim \text{Po}(3\lambda)$ and statement $P(F = 1) \times P(Y = 1)$ award M0M1		
	A1 for awrt 0.0106 (correct ans with no incorrect working scores 3/3)		

Question	Scheme	Marks	AOs
1(a)(i)	$X \sim \text{Po}(24)$	B1	3.4
	$P(X = 26) = 0.071912\dots$ awrt <u>0.0719</u>	B1	1.1b
		(2)	
(ii)	$P(X \geq 21) = 1 - P(X \leq 20) [= 1 - 0.24263\dots]$	M1	3.4
	$= 0.75736\dots$ awrt <u>0.757</u>	A1	1.1b
		(2)	
(b)	$H_0: \lambda = 2$ [$\mu = 16$] $H_1: \lambda < 2$ [$\mu < 16$]	B1	2.5
	$P(Y \leq 10 Y \sim \text{Po}(16)) = 0.077396\dots$ awrt <u>0.0774</u>	B1	1.1b
	Not significant / Do not reject H_0 / 10 is not in the CR	M1	1.1b
	There is <u>not</u> sufficient evidence to suggest a decrease/change in the rate of <u>customers</u> entering Jeff's supermarket.	A1	2.2b
		(4)	
(c)	Use of $\text{Po}(8)$ to attempt critical region	M1	2.1
	Critical region is $Y \leq 3$ / H_0 is not rejected when $Y \geq 4$	A1	1.1b
	True distribution is $W \sim \text{Po}(4)$	B1	2.1
	$P(W \geq 4 W \sim \text{Po}(4)) = 1 - P(W \leq 3) [= 1 - 0.43347\dots]$	M1	1.1b
	$= 0.56652\dots$ awrt <u>0.567</u>	A1	1.1b
		(5)	
(13 marks)			
Notes			
(a)(i) (ii)	B1: For realising the distribution is $\text{Po}(24)$ (May be seen or implied in part (ii)) B1: awrt 0.0719 M1: Writing or using $1 - P(X \leq 20)$ A1: awrt 0.757		
(b)	B1: Both hypotheses correct (must use μ or λ) B1: awrt 0.0774 Allow awrt 0.08 from a correct probability statement. allow CR: $X \leq 9$ M1: Correct non-contextual conclusion (may be implied by correct contextual conclusion). Allow a f.t. comparison of 'their p ' with 0.05 (Ignore any contradictory contextual comments for this mark) A1: A fully correct solution drawing a correct inference in context with all previous marks in (b) scored.		
(c)	M1: Use of $\text{Po}(8)$ to attempt critical region [$P(Y \leq 3) = 0.0423\dots$, $P(Y \leq 4) = 0.0996\dots$] A1: Finding critical region for the test $Y \leq 3$ which must come from $\text{Po}(8)$. B1: Identifying the need to use $\text{Po}(4)$ as the true distribution. Allow $\text{Po}(4)$ seen or used for this mark. M1: Writing or using $P(W \geq '4')$ or $1 - P(W \leq '3')$ from $\text{Po}(4)$. Allow f.t. on their identified CR but must be using $\text{Po}(4)$ A1: awrt 0.567		

Question	Scheme	Marks	AOs
2(a)	requires large n /small p so not a good approximation	B1	3.5b
		(1)	
(b)	X and Y must be independent	B1	2.4
		(1)	
(c)	$P(X + Y < 2.4)$ from Po(7) $[P(X + Y \leq 2)]$	M1	3.4
	$= 0.029636\dots$ awrt <u>0.0296</u>	A1	1.1b
		(2)	
(4 marks)			
Notes			
(a)	B1: Correct reason why the model would not be appropriate and correct conclusion. Condone e.g. ' p is close to 0.5' for p is not small. Mean is not equal to variance on its own in B0.		
(b)	B1: Correct explanation mentioning independence (oe). Ignore extraneous comments.		
(c)	M1: Using Po(7) with 2.4 A1: awrt 0.0296		

Question	Scheme	Marks	AOs
2(a)	$C \sim \text{Poisson}(3.75)$	M1	3.3
	$P(C \geq 2) = 0.88829...*$ awrt 0.8883*	A1*cso	1.1b
		(2)	
(b)	$D \sim B(6, "0.888")$	M1	3.3
	$P(D \leq 3) = 0.02163...$ awrt 0.0216 / 0.0215	A1	1.1b
		(2)	
(c)	$P(C = 8) = 0.02281...$	B1	1.1b
	$E \sim B(150, "0.02281...") \Rightarrow \text{mean} = 150 \times "0.02281..." [= 3.4215...]$	M1	3.3
	$E \sim \text{Po}("3.4215...") \Rightarrow P(E \geq 3) = [1 - P(E \leq 2)]$	M1	3.4
	$= 0.664 *$	A1*cso	2.1
		(4)	
(d)	The number of periods is large and the probability of receiving 8 calls in 30-minutes is small.	B1 (1)	2.4
(e)	$H_0: \lambda = 30 \quad H_1: \lambda \neq 30$	B1	2.5
		(1)	
(f)	$X \sim \text{Po}(30)$	B1	3.3
	$P(X \geq 40) = 1 - P(X \leq 39)$	M1	1.1b
	$= 0.04625...$	A1	1.1b
	0.046... > 0.025 or no evidence to reject H_0 There is insufficient evidence at the 5% level of significance that the number of calls received is different on a Saturday	A1 (4)	2.2b

(14 marks)

Notes:

(a)	M1:	For calculating the mean and setting up the correct model. Poisson may be implied by 0.8883 or better or $1 - \text{awrt } 0.1117$ but must see 3.75 or 1.25×3
	A1*cso:	$P(C \geq 2) = \text{awrt } 0.8883$ or $1 - \text{awrt } 0.1117 = 0.888$ Must see $P(C \geq 2)$ oe
(b)	M1:	Setting up a new model using their answer to (a) Implied by correct answer
	A1:	awrt 0.0216 or awrt 0.0215
(c)	B1:	awrt 0.0228
	M1:	Setting up a new model $B(150, "0.0228")$ and using np (working seen if incorrect)
	M1:	Using the model $\text{Po}(\text{their } np)$ Must be clearly stated and $P(E \geq 3)$ oe seen
	A1*cso:	Only award if the previous 3 marks have been awarded and 0.664 is stated. NB Use of $B(150, 0.02281)$ gives 0.668
(d)	B1:	Idea that $n = 150$ (number of periods selected) is large and p is 0.022... (exactly 8 calls in the time period) is small.
(e)	B1:	Both hypotheses correct using λ or μ allow 1.25 or 3.75
(f)	B1:	Realising $\text{Po}(30)$ needs to be used. NB Implied by correct answer or $P(X = 40) = 0.0139...$
	M1:	Writing or using $1 - P(X \leq 39)$ or if CR method for $P(X \geq 42) = 0.0221...$
	A1:	0.04... or awrt 0.05 or CR $X \geq 42$ oe must be CR and not probability
	A1:	A fully correct solution and correct inference in context. Calls required If put this prob but then give Cr $X \geq 40$ M1A1A0

Question	Scheme		Marks	AOs														
4(a)	$4E(N) + 2 = 14.8$ or $E(N) = 3.2$		M1	3.1a														
	$0.2 + 0.1 + 0.75 + 4b + 5c = 3.2$		M1	1.1b														
	$\frac{c}{0.25 + b + c} = 0.5$ or $0.25 = c - b$		M1	3.1a														
	$b = 0.1$ and $c = 0.35$																	
	$E(N^2) = 1 \times 0.2 + 4 \times 0.05 + 9 \times 0.25 + 16 \times "0.1" + 25 \times "0.35" [= 13]$		M1	1.1b														
	$\text{Var}(N) = "13" - "3.2" ^2$		dM1	1.1b														
	$= 2.76$ *		A1*	2.1														
			(6)															
(b)	<table border="1"> <tr> <td>fee</td> <td>0</td> <td>50</td> <td>70</td> <td>90</td> <td>100</td> <td>100</td> </tr> <tr> <td>$P(N = n)$</td> <td>a</td> <td>0.2</td> <td>0.05</td> <td>0.25</td> <td>b</td> <td>c</td> </tr> </table>		fee	0	50	70	90	100	100	$P(N = n)$	a	0.2	0.05	0.25	b	c	M1	3.3
	fee	0	50	70	90	100	100											
	$P(N = n)$	a	0.2	0.05	0.25	b	c											
	$50 \times 0.2 + 70 \times 0.05 + 90 \times 0.25 + 100 \times "0.1" + 100 \times "0.35"$		M1	1.1b														
$= 81\text{p}$		A1	1.1b															
		(3)																
(c)	Poisson distribution will assign substantial probability to $N > 5$		B1	3.5b														
			(1)															
(10 marks)																		
Notes																		
(a)	M1:	For using the given information to find $E(N)$																
		ALT $a + b + c = 0.5$ oe																
	M1:	For use of $\sum nP(N = n) = "3.2"$ At least 3 terms correct																
		ALT $\sum (4n + 2)P(N = n) = 14.8 \Rightarrow 2a + 1.2 + 0.5 + 3.5 + 18b + 22c = 14.8$ At least 3 terms correct																
	M1:	Forming an equation in b and c using conditional probability																
	M1:	For using $\sum n^2P(N = n)$ Allow with the letters b and c																
	dM1:	Dependent on previous method mark. Correct method to find $\text{Var}(N)$																
	A1*:	All previous marks must be awarded and 2.76 stated																
(b)	M1:	Setting up a new model with the correct fees. At least 3 terms correct. Allow 0.5, 0.7, 0.9, 1																
	M1:	Correct method for calculating $E(\text{fee})$ Allow with the letters b and c																
	A1:	81[p] No units needed. Allow 0.81 if fees are in pounds																
(c)	B1:	A correct limitation.																

Qu	Scheme	Marks	AOs
3(a)	$W \sim \text{Po}(11.2)$ and $P(W \leq 19) = 1 - P(W \geq 18)$ <u>or</u> suitable 3sf probs $P(W \leq 19) = 0.020776...$ awrt 0.021	M1	3.4
		A1 (2)	1.1b
(b)	$[S = \# \text{ calls per day}, S \sim \text{Po}(0.4)]$ $P(S > 1) = 0.061551...$ awrt 0.0616 $X \sim B(250, "0.061551...")$ $Y \sim \text{Po}("15.3879...")$ [Accept $\text{Po}(15.4)$ or better] <u>or</u> suitable 3sf probs $= 0.14751...$ awrt 0.148	B1	1.1b
		M1	3.3
		M1	3.4
		A1 (4)	1.1b
(c)	$H_0: \lambda = 16.8$ $H_1: \lambda < 16.8$ $U \sim \text{Po}(16.8)$ $P(U \leq 8) = 0.014$ [0.014 < 0.05 or there is sufficient evidence to reject H_0] There is sufficient evidence at the 5% level of significance that the <u>number of calls received per day is lower in winter</u> <u>or rate of calls is lower in winter or less calls per day in winter (o.e.)</u>	B1	2.5
		B1	3.3
		M1	1.1b
		A1 (4)	2.2b
(d)	$C \sim \text{Po}(0.4 \times n + 0.2 \times n) [= \text{Po}(0.6n)]$ <u>or</u> $D \sim B(n, e^{-0.6})$ or awrt 0.549) $e^{-0.6n} < 0.001$ <u>or</u> $-0.6n < \ln(0.001)$ <u>or</u> $n > 11.5...$ $n = \underline{12}$	M1	3.1b
		M1	1.1b
		A1	1.1b
		(3)	
(e)	The <u>rate of calls per day is constant or the number of calls occurring in non-overlapping time intervals is independent.</u> <u>or number of calls per day is independent (o.e.)</u>	B1 (1)	2.4
Total 14			
(a)	M1 A1	For using the model $\text{Po}(11.2)$ implied by sight of: 0.02077... or 0.9889.. or 0.9792.. awrt 0.021	
(b)	B1	awrt 0.0616	
	1st M1	Setting up a new model $B(250, "0.0616")$ [condone $B("0.0616", 250)$]	
	2nd M1 A1	Seeing the model $\text{Po}(\text{their } np)$ implied by sight of: 0.1475.. or 0.89975 or 0.8524... awrt 0.148	
SC		if no approximation used (and 1 st M1 not seen) an answer of awrt 0.140 could get B1M1M0A0	
(c)	1st B1	Both hypotheses correct using λ or μ and 16.8 or 0.4 [Accept their ans to 0.4×42]	
	2nd B1	Realising $\text{Po}(16.8)$ needs to be used. Sight or use of, implied by correct prob or CR	
	M1	For 0.014 or better (0.0141..) or CR $X \leq 9$ oe must be CR and not probability. [Allow CR $X \leq 10$ with probability $P(X \leq 10) = 0.054$ or better]	
	A1	Indep of 1st B1 (must see 2 nd B1 and M1 scored) for a correct inference in context	
(d)	1st M1	Selecting a suitable model. Sight of $\text{Po}(0.6n)$ <u>or</u> $B(n, e^{-0.6})$ or implied by 2 nd M1	
	2nd M1	For a correct inequality or equality involving n [Condone slips in solving] Allow MR i.e. misread of 0.01 for 0.001 (or similar) to score M1M1A0	
	A1	$n = 12$ cao [Correct answer with no incorrect working seen scores 3/3]	
(e)	B1	Allow equivalent statements. Underlined words required.	

Qu 2	Scheme	Marks	AO	
(a)	$H_0 : \lambda = 1.7$ $H_1 : \lambda \neq 1.7$	B1	2.5	
	[$X = \text{no. of calls in 10 mins}$] $X \sim \text{Po}(17)$	M1	3.3	
	[$P(X \geq 25) = 1 - P(X \leq 24)$] = 0.0406463... <u>or</u> CR: $X \geq 27$	A1	3.4	
	[0.04... > 0.025/ 25 is not in CR so not significant]	A1	2.2b	
	insufficient evidence of a change in <u>rate of calls</u>			
			(4)	
	(b)	[$T = \text{no. of calls longer than 8 minutes}$] $T \sim B(70, 0.012)$	M1	3.3
		[$P(T > 2) =$] $P(T \geq 3) = 1 - P(T \leq 2) = 1 - 0.947725...$	M1	3.4
		= awrt 0.0523	A1	1.1b
			(3)	
	(c)	[$C = \text{no. of calls out of 900 longer than 30 mins}$]	M1	3.3
		[$C \sim B(900, p)$] $C \approx \sim \text{Po}(900p)$		
$P(C = 0) \approx e^{-900p} = 0.05$		M1	3.4	
$900p = -\ln(0.05)$ [= 2.9957...]		M1	1.1b	
$p = 0.003328...$ awrt 0.00333		A1	1.1b	
		(4)		
(11 marks)				
Notes				
(a)	B1 for both hypotheses correct which must be attached to H_0 and H_1 must be in terms of λ or μ allow either 1.7 or 17			
	M1 for stating or using the correct Poisson model. may be implied by sight of awrt 0.0406/7 <u>or</u> awrt 0.959 <u>or</u> 0.9747... or better			
	1 st A1 for correct prob of awrt 0.04 or for correct CR found $X \geq 27$ ($X > 26$) (ignore lower tail CR if found) allow CV $X = 27$			
	2 nd A1 (dep on M1A1) for a correct conclusion in context mentioning "rate of calls" o.e. Allow e.g. 'The rate of calls is 1.7 per minute/17 per 10 minutes' Must be rate o.e. not "number"			
	A0 if inconsistent comments are seen e.g. "reject H_0 , no change in rate of calls"			
	(b)	1 st M1 for sight or use of the correct binomial model. may be implied by sight of awrt: 0.0523 <u>or</u> 0.948 <u>or</u> 0.795 <u>or</u> 0.205		
		2 nd M1 for correct interpretation of more than 2 (allow $1 - 0.95$ or better)		
		A1 for awrt 0.0523 (correct answer only scores 3 out of 3)		
	SC: Use of $\text{Po}(70 \times 0.012)$ leading to an answer of 0.0533(45...) and scores M1M1A0			
	(c)	1 st M1 for sight or use of $\text{Po}(900p)$ (as a suitable approx. to $B(900, p)$) (may be implied by correct answer awrt 0.00333)		
		2 nd M1 for a correct equation in p <u>or</u> correct use of $P(C = 0)$ from Po e.g. $e^{-\lambda} = 0.05$		
		3 rd M1 for a correct method to solve for p (allow $p = \pm \ln(0.05)/900$) <u>or</u> to solve for λ , i.e. $\lambda = \text{awrt } 3(.00)$		
A1 for $p = \text{awrt } 0.00333$ Must see Po used condone $\frac{1}{300}$ o.e. Allow standard form (awrt 3.33×10^{-3}) or percentage (awrt 0.333%)				
SC: Use of Binomial gives 0.003323... awrt 0.00332 scores M0M0M0A1				

Qu	Scheme	Mark	AO
2 (a)	(i) 0.20901...	awrt 0.209	B1 3.4
	(ii) 0.30844..	awrt 0.308	B1 1.1b
(b)	$H_0: \lambda = 2.4$ (or $\mu = 6$) $H_1: \lambda \neq 2.4$ (or $\mu \neq 6$)		B1 2.5
	[$E =$ no. of errors] $E \sim \text{Po}(6)$		M1 3.3
	$P(E \leq 1) = 0.0174$ <u>or</u> $P(E \leq 2) = 0.0620$ and $P(E \leq 11) = 0.980$ <u>or</u> $P(E \geq 12) = 0.0201$		M1 3.4
	Critical region: $E \leq 1$ or $E \geq 12$		A1 1.1b
(c)	[$P(\text{Type I error}) = 0.0174 + 0.0201 =$] 0.0375 (Calc gives: $0.017351\dots + 0.0200919\dots = 0.037443\dots$)		B1ft 1.2
			(1)
(7 marks)			
Notes			
(a)	1 st B1 for awrt 0.209 2 nd B1 for awrt 0.308		
(b)	B1 for both hypotheses correct in terms of λ or μ (allow $\lambda = 6$ etc) 1 st M1 for selecting the correct model. Sight or use of $\text{Po}(6)$ 2 nd M1 for use of the correct model with two probs correct to 2.s.f. (accept $P(E \geq 12) = 0.02$) Must see attempt at lower and upper limit. Probabilities may be seen in (c). A1 for correct critical region (both parts). Allow $E \leq 1$ and $E \geq 12$ or $E \leq 1, E \geq 12$ etc Writing CR as probability statements is A0 NB: Completely correct CR implies M1M1A1		
(c)	B1ft for 0.0375 or 0.0374 <u>or</u> summing their two appropriate probs (ft their CR) NB: If candidate uses a 1-tailed test, this mark cannot be gained		

Paper 3: Further Statistics 1 Mark Schemes

Question	Scheme	Marks	AOs	
Q1	$H_0 : \lambda = 5$ ($\lambda = 2.5$) $H_1 : \lambda > 5$ ($\lambda > 2.5$)	B1	2.5	
	$X \sim \text{Po}(2.5)$	B1	3.3	
	Method 1:	Method 2:		
	$P(X \geq 7) = 1 - P(X \leq 6)$ $= 1 - 0.9858$	$P(X \geq 5) = 0.1088$ $P(X \geq 6) = 0.042$	M1	1.1b
	$= 0.0142$	CR $X \geq 6$	A1	1.1b
	$0.0142 < 0.05$ $7 \geq 6$ or 7 is in critical region or 7 is significant Reject H_0 . There is evidence at the 5% significance level that the level of pollution has increased. or There is evidence to support the scientists claim is justified		A1cso	2.2b
(5 marks)				
Notes:				
B1: Both hypotheses correct using λ or μ and 5 or 2.5				
B1: Realising that the model $\text{Po}(2.5)$ is to be used. This may be stated or used				
M1: Using or writing $1 - P(X \leq 6)$ or $1 - P(X < 7)$ a correct CR or $P(X \geq 5) = \text{awrt } 0.109$ and $P(X \geq 6) = \text{awrt } 0.042$				
A1: awrt 0.0142 or CR $X \geq 6$ or $X > 5$				
M1: A fully correct solution and drawing a correct inference in context				

Question	Scheme	Marks	AOs
Q2(a)	$P(X \geq 1) = 1 - P(X = 0)$ $1 - P(X = 0) = 0.049$	B1	3.1b
	$P(X = 0) = 0.951$	B1	1.1b
	$x^5 = 0.951$ $x = 0.99$	M1	3.1b
	$p = 0.01$	A1	1.1b
	$X \sim B(1000, 0.01)$	M1	3.3
	Mean = $np = 10$	A1ft	1.1b
	Variance = $np(1 - p) = 9.9$	A1ft	1.1b
		(7)	
(b)	$X \sim \text{Po}("10")$ then require: $P(X > 6) = 1 - P(X \leq 6)$	M1	3.4
	$= 1 - 0.1301$		
	$= 0.870$	A1	1.1b
		(2)	
(c)	The approximation is valid as : the number of calls is large	B1	2.4
	The probability of connecting to the wrong agent is small	B1	2.4
		(2)	
(d)	The answer is accurate to 2 decimal place	B1	3.2b
		(1)	
			(12 marks)
Notes:			
(a)			
B1: Realising that the $P(\text{at least 1 call}) = 1 - P(X = 0)$			
B1: Calculating $P(X = 0) = 0.951$			
M1: Forming the equation $x^5 = "their 0.951"$ may be implied by $p = 0.01$			
A1: 0.01 only			
M1: Realising the need to use the model $B(1000, 0.01)$ This may be stated or used			
A1: Mean = 10 or ft their p but only if $0 < p < 1$			
A1: Var = 9.9 or ft their p but only if $0 < p < 1$			
(b)			
M1: Using the model $\text{Po}("their 10")$ (this may be written or used) and $1 - P(X \leq 6)$			
A1: awrt 0.870 Award M1 A1 for awrt 0.870 with no incorrect working			

Question 2 notes continued

(c)

B1: Explaining why approximation is valid - need the context of number and calls

B1: Need the context connecting, wrong agent

(d)

B1: Evaluating the accuracy of their answer in (b). Allow 2 significant figures

Question	Scheme	Marks	AOs
3(a)	$W \sim \text{Po}(0.45n)$	M1	3.1b
	$[P(W = 0) =] e^{-0.45n} < 0.05$	M1	1.1b
	$n > 6.657\dots$		
	$n = 7$	A1	1.1b
		(3)	
(b)	$X \sim \text{Po}(5 \times 0.45 + 5 \times 0.2)$ [Po(3.25)]	M1	3.3
	$P(X = 2) = 0.20478\dots$ awrt 0.205	A1	1.1b
	The model is only valid if Tim and Sue make errors independently	B1	3.5b
		(3)	
(c)	$P(X = 0) = 0.03877\dots$	M1	3.1b
	$Y \sim B(10, '0.03877\dots')$	M1	3.3
	$P(Y \geq 2) = 1 - P(Y \leq 1)$	M1	1.1b
	= awrt 0.055	A1	1.1b
		(4)	
(10 marks)			
Notes			
(a)	1 st M1 Understanding that a P(0.45n) model is required here		
	2 nd M1 For correct inequality		
	A1 $n = 7$ cao		
(b)	M1 Setting up a combined Po model		
	A1 awrt 0.205		
	B1 Understanding that model is only valid if the two parts are independent		
(c)	1 st M1 For using Poisson distribution		
	2 nd M1 Setting up binomial distribution		
	3 rd M1 For finding $1 - P(Y \leq 1)$ from binomial		
	2 nd A1 awrt 0.055		