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January 2018

Question	Scheme	Marks
4.(a)	$np = 4.2$ $\quad np(1-p) = 3.57$	M1
	leading to $(1-p) = 0.85$	M1
	$p = 0.15$ $\quad n = 28$	A1 A1
		(4)
(b)	X~B(25, 0.35)	
	$\mathrm{E}(X) = 8.75$	B1
	$[\mathrm{P}(X > 8.75) = \mathrm{P}(X \geq 9) =]$	
	$1 - \mathrm{P}(X \leq 8) = 1 - 0.4668 = 0.5332$ **awrt <u>0.533</u>**	M1 A1
		(3)

June 2018

Question Number	Scheme	Marks
1(a)(i)	$\mathrm{P}(M = 1) = 0.315124\ldots$ awrt **<u>0.315</u>**	B1
(ii)	$\mathrm{P}(M \geqslant 3) = 1 - \mathrm{P}(M \leqslant 2)$	M1
	$= 1 - 0.9885$ awrt **<u>0.0115</u>**	A1
		(3)
(b)	$n \times 0.05 = 3$ (o.e.)	M1
	<u>$n = 60$</u>	A1
		(2)
(c)	$[\mathrm{P}(F \geqslant 1) > 0.99 \;\Rightarrow]\; 1 - \mathrm{P}(F = 0) > 0.99$	M1
	$1 - 0.95^n > 0.99$ <u>or</u> $0.95^n < 0.01$ (o.e.)	M1
	$n \log 0.95 < \log 0.01$ <u>or</u> $n > \dfrac{\log 0.01}{\log 0.95}$ [= 89.78…]	M1
	<u>$\therefore n = 90$</u>	A1cso
		(4)

October 2018

Question	Scheme	Marks
2.(a)	$X \sim B(12, 0.2)$	B1
	$P(X < 3) = P(X \le 2) = 0.5583\ldots$ awrt **0.558**	M1A1
		(3)
(b)(i)	[P(customer takes sugar) =] $0.8 \times 0.35 + 0.2 \times 0.6$ [= 0.4*]	B1cso
		(1)
(ii)	[Y ~] $B(n, 0.4)$	B1
		(1)
(c)(i)	$P(Y = 4)$ [$= {}^{10}C_4(0.4^4)(0.6^6) = 0.6331 - 0.3823$] $= 0.2508$ awrt **0.251**	B1
		(1)
(ii)	$P(Y \le 6 \mid Y \ge 3) = \dfrac{P(3 \le Y \le 6)}{P(Y \ge 3)}$	M1
	$\dfrac{P(Y \le 6) - P(Y \le 2)}{1 - P(Y \le 2)} = \dfrac{0.9452 - 0.1673\ [= 0.7779]}{1 - 0.1673\ [= 0.8327]} = 0.934\ldots$ awrt **0.934**	M1A1
		(3)

January 2019

Question Number	Scheme	Marks
1. (a)	Any one response in context from :	
	Each person **turns up** independently/randomly of others oe	B1
	Probability/proportion/percentage of not **turning up** remains constant (5%) oe	
		(1)
(b)	$X \sim B(50, 0.05)$	
(i)	[$P(X = 0)$ =] $0.076944\ldots$ awrt **0.0769**	B1
(ii)	$P(X = 1) = 0.2794 - 0.0769 = 0.20248...$ awrt **0.202/0.203**	M1A1
		(3)
(c)	Let T = total earnings for a journey	
	see table below	M1
	$E(T) = 880 \times$ "0.0769" $+ 940 \times$ "0.2025" $+ 1000 \times (1 - ($"0.0769+0.2025"$))$	dM1
	=£978.62 awrt (£) **979**	A1
		(3)
	Alternative	**Alternative**
	Let S = possible pay out	
	see table below	M1
	$E(T) = 1000 - (120 \times$ "0.0769" $+ 60 \times$ "0.2025"$)$	dM1
	=£978.62 awrt (£) **979**	A1
		[7 marks]

T	880	940	1000
$P(T = t)$	"0.0769"	"0.2025"	(1 – ("0.0769"+"0.2025"))=[0.7206]

S	60	120
$P(S = s)$	"0.2025"	"0.0769"

June 2019

Question Number	Scheme	Marks
6(a)	Any two from: • **Probability** that a **pot** will **crack** is constant (0.3) • **Pots crack** independently/randomly • **Batch size** / number of **pots fired** (n) is constant	B1B1 (2)
(b)	[$8 \times 0.3 =$] 2.4	B1 (1)
(c)	Let X = number of pots which crack $X \sim \text{B}(8, 0.3)$ $\text{P}(X = 2) = {}^8C_2 \times 0.3^2 \times 0.7^6$ $= 0.29647\ldots$ awrt 0.296/0.297	 M1 A1 (2)
(d)	$\text{P}(X \leqslant 5) = 0.9887$ [$k =$] 6	M1 A1 (2)

October 2019

Question	**Scheme**	**Marks**
1(a)	$X \sim \text{B}(4, p)$ or $Y \sim \text{B}(4, 1-p)$ $\text{P}(X > 2) = \text{P}(X = 3) + \text{P}(X = 4) = 4p^3(1-p) + p^4$ oe $= p^3(4(1-p) + p)$ $= p^3(4 - 3p)$ *	B1 M1 A1cso (3)
(b)	$\sqrt{4p(1-p)} = 0.96$ $4p(1-p) = 0.9216 \rightarrow 4p^2 - 4p + 0.9216 = 0$ $p = \dfrac{16}{25}$ or 0.64 $\text{P}(X > 2) = 0.54525952$ awrt **<u>0.545</u>**	M1 M1 A1 A1 (4)
(c)	$\text{P}(X = 3 \mid X > 2) = \dfrac{4'p'^3(1-'p')}{'(b)'} = \dfrac{4 \times 0.64^3(0.36)}{0.545...}, = \dfrac{9}{13}$ awrt **<u>0.692</u>**	M1, A1 (2) **Total [9]**

January 2020

Question	Scheme		Marks
2(a)	$E \sim B(6, 0.35)$		B1
(i)	$P(E=2) = P(E \le 2) - P(E \le 1)$ or $\left({}^6C_2\right)0.35^2(1-0.35)^4$		M1
	$= 0.6471 - 0.3191$		
	$= 0.328$	awrt **<u>0.328</u>**	A1
(ii)	$P(E \ge 4) = 1 - P(E \le 3)$ or $1 - 0.8826$		M1
	$= 0.1174$	awrt **<u>0.117</u>**	A1
			(5)

(c)	Expected profit before supplement = $"0.1174"\times 1.20 + (1 - "0.1174")\times 0.60$		M1
	$= (£)0.67044$		
	$P(X \ge 4) = 0.2553$	awrt 0.255	B1
	Expected profit per box after supplement $= "0.2553"\times 1.20 + (1 - "0.2533")\times 0.60 - "0.67044"$		M1
	$= (£)0.08274$		A1
	OR Expected profit per box after supplement $= "0.2553"\times 1.20 + (1 - "0.2553")\times 0.60 - 0.10$		(M1)
	$= (£)0.65318$		(A1)
	Kiyoshi should not continue to add the supplement (as 0.0827 < 0.10 or 0.653 < 0.67[0])		A1cso
			(5)

October 2020

Question Number	Scheme		Marks
3(a)(i)	$X \sim B(10,\ 0.45)$		M1
	$P(X \le 1) = 0.0233$	awrt 0.0233	A1
(ii)	$P(X \ge 6) = 1 - P(X \le 5)$ or $1 - 0.7384$		M1
	$= 0.2616\ldots$	awrt 0.262	A1
			(4)

January 2021

Question Number	**Scheme**		**Marks**
1(a)	B(30, 0.05)		B1
			(1)
(b)	The **probability**(oe) of an <u>oyster</u> surviving/not surviving is **constant**		B1
	The survival of each <u>oyster</u> is **independent** of the others		(1)
(c)(i)	${}^{30}C_{24}(0.05)^6(0.95)^{24}$ oe		M1
	$= 0.002708\ldots$	awrt 0.0027	A1
(ii)	$P(Y \geqslant 3) = 1 - P(Y \leqslant 2)$ from $Y \sim B(30, 0.05)$ or $P(X \leqslant 27)$ from $X \sim B(30, 0.95)$		M1
	$= 1 - 0.8122$		
	$= 0.1878$	awrt 0.188	A1
			(4)

June 2021

Question Number	Scheme	Marks
	Throughout the paper the candidates may use different letters to the ones given in the mark scheme.	
1. (a)	[$X \sim$ the number of pansy seeds that do not germinate or $Y =$ the number…that <u>do</u> germinate] $X \sim \mathrm{B}(20, 0.05)$ <u>or</u> $Y \sim \mathrm{B}(20, 0.95)$	B1
(i)	$\mathrm{P}(X \leqslant 4) - \mathrm{P}(X \leqslant 2) = 0.9974 - 0.9245$ <u>or</u> $\binom{20}{3}0.05^3 \times 0.95^{17} + \binom{20}{4}0.05^4 \times 0.95^{16} = 0.05958... + 0.01332...$	M1
	$= 0.072909...$ awrt <u>**0.0729**</u>	A1
(ii)	$\mathrm{P}(X \leqslant 1)$ <u>or</u> $\mathrm{P}(Y \geqslant 19) = 20 \times (0.95)^{19}(0.05) + (0.95)^{20}$	M1
	$= 0.7358$ $= 0.735839...$ awrt <u>**0.736**</u>	A1 (5)
(b)	[Let W = no. of packets where $Y > 18$] $\mathrm{P}(W = 5) = (\text{"}0.7358...\text{"})^5$	M1
	$= 0.21573...$ awrt <u>**0.216**</u>	A1
		(2)

October 2021

Question Number	Scheme		Marks
	Throughout the paper the candidates may use different letters to the ones given in the mark scheme.		
1(a)	$\mathrm{P}(F \geqslant 12) = 1 - \mathrm{P}(F \leqslant 11)$		M1
	$= 0.34517...$ awrt 0.345		A1
			(2)
(b)	$\mathrm{P}(8 \leqslant F < 15) = \mathrm{P}(F \leqslant 14) - \mathrm{P}(F \leqslant 7)$		M1
	$=0.81104...$ awrt 0.811		A1
			(2)
(c)	$3(30 - F) + F < 70$ or $F > 10$	$3(R) + 30 - R < 70$ or $R < 20$	M1
	$\mathrm{P}(F > 10) = 1 - \mathrm{P}(F \leqslant 10)$	$\mathrm{P}(R < 20) = \mathrm{P}(R \leqslant 19)$	M1
	$= 0.4922...$ awrt 0.492		A1
			(3)

January 2022

Question Number	Scheme	Marks
5 (a)	$\mathrm{B}(n, 0.045)$	B1
		(1)
(b)	<u>Applicants</u> are independent (no identical twins) or the <u>proportion/probability</u> identified as <u>colour blind</u> does not change over time	B1
		(1)

June 2022

Question	Scheme	Marks
7. (a)	$Y \sim B(20, p)$ $p =$ P(sample contains counter with a 9 on it)	
	$p = \left(1 - \frac{9}{10} \times \frac{8}{9} \times \frac{7}{8}\right)$ oe **or** $\left(\frac{1}{10} \times \frac{9}{9} \times \frac{8}{8} \times 3\right)$ oe **or** $\left(\frac{6}{10} \times \frac{5}{9} \times \frac{1}{8} \times 3 + \frac{6}{10} \times \frac{3}{9} \times \frac{1}{8} \times 6 + \frac{3}{10} \times \frac{2}{9} \times \frac{1}{8} \times 3\right)$ oe $\left[= \frac{3}{10}\right]$	M1A1
(i)	$E(Y) = 20 \times "\tfrac{3}{10}" [= 6]$	B1
(ii)	$Var(Y) = 20 \times "\tfrac{3}{10}" \times (1 - "\tfrac{3}{10}") = 4.2$	M1A1
		(5)

October 2022

Question Number	Scheme	Marks
4(a)	$X \sim B(20,\ 0.4)$	M1
	$P(5 \leqslant X < 8) = P(X \leqslant 7) - P(X \leqslant 4)$ or $0.4159 - 0.0510$	M1
	$= 0.3649$ awrt 0.365	A1
		(3)

January 2023

Question Number	Scheme	Marks
3 (a) (i)	$X \sim B(10, 0.1)$	
	$P(X \geqslant 4) = 1 - P(X \leqslant 3) = 1 - 0.9872$	M1
	$= 0.0128$ awrt 0.0128	A1
(ii)	$P(1 < X < 5) = P(X \leqslant 4) - P(X \leqslant 1) = 0.9984 - 0.7361$ or $P(X = 2) + P(X = 3) + P(X = 4) = 0.1937 + 0.0574 + 0.0112$	M1
	$= 0.2623$ awrt 0.262	A1
		(4)

June 2023

Question Number	Scheme	Marks
1. (a)(i)	$X \sim B(50, 0.4)$	
	$P(X = 26) = 0.9686 - 0.9427$ or ${}^{50}C_{26}\,(0.4)^{26}(0.6)^{24}$	M1
	awrt **0.0259**	A1
		(2)
(ii)	$P(X \geqslant 26) = 1 - P(X \leqslant 25)$	M1
	$= 1 - 0.9427 =$ awrt **0.0573**	A1
		(2)
(iii)	(From tables) $k =$ **19**	B1
		(1)

October 2023

Question Number	Scheme	Marks
1 (a) (i)	$X \sim B(14, 0.2)$	
	$\left[P(X=2)=\right]{}^{14}C_2 \times 0.2^2 \times 0.8^{12}$	M1
	$= 0.2501$ awrt 0.2501	A1
(ii)	$X \sim B(25, 0.2)$	
	$P(X>3) = 1 - P(X \leqslant 3) = 1 - 0.2340$ or $1-(0.0038 + 0.0236 + 0.0708 + 0.1358)$	M1
	$= 0.7660$ awrt 0.766	A1
		(4)

January 2024

Question Number	Scheme	Marks
6(a)	8, 11, 14, 17, 20	M1
	$\left[P(\text{even})=\right]\frac{1}{5}$ and $\left[P(\text{odd})=\right]\frac{4}{5}$	M1
	$\left[P(X=8)=\right]\left(\frac{4}{5}\right)^4$ or $\left[P(X=20)=\right]\left(\frac{1}{5}\right)^4$	M1
	$\left[P(X=11)=\right]4\times\left(\frac{1}{5}\right)\left(\frac{4}{5}\right)^3$ or $\left[P(X=17)=\right]4\times\left(\frac{4}{5}\right)\left(\frac{1}{5}\right)^3$	M1
	$\left[P(X=14)=\right]{}^4C_2\times\left(\frac{1}{5}\right)^2\left(\frac{4}{5}\right)^2$	M1
	X: 8, 11, 14, 17, 20 $P(X=x)$: $\frac{256}{625}$ (0.4096), $\frac{256}{625}$ (0.4096), $\frac{96}{625}$ (0.1536), $\frac{16}{625}$ (0.0256), $\frac{1}{625}$ (0.0016)	A1
		(6)
(b)	$1-(1-\text{"}0.1536\text{"})^n > 0.95$ or $(\text{"}0.8464\text{"})^n < 0.05$	M1
	$n > 17.96$ or $n > \frac{\log(0.05)}{\log(\text{"}0.8464\text{"})}$ or $n > \log_{\text{"}0.8464\text{"}}(0.05)$	M1
	$n = 18$	A1
		(3)

Inner table of 6(a):

X	8	11	14	17	20
$P(X=x)$	$\frac{256}{625}$ (0.4096)	$\frac{256}{625}$ (0.4096)	$\frac{96}{625}$ (0.1536)	$\frac{16}{625}$ (0.0256)	$\frac{1}{625}$ (0.0016)