October 2019
WST02 STATISTICS 2
Mark Scheme

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

	Notes
(a)	B1 writing or using B(4, p) or B(4, $1-p$). For using, a correct term for $P(X = a)$ where $1 \leqslant a \leqslant 3$ is needed. M1 correct expression for $P(X > 2)$ in terms of p. Allow $^4C_0$ etc oe A1 cso correct working leading to given answer (must see at least one line of intermediate working eg $p^4 + 4p^3 - 4p^4$). NB Do not allow same line but with $^4C_0$ etc calculated as an intermediate line. If they use $P(X > 2) = 1 - P(X = 0) - P(X = 1) - P(X = 2)$ then we need to see a completely correct solution as per the alternatives given below.
(b)	1st M1 for a correct **equation** for standard deviation or variance. Allow with " their p" eg $\frac{p}{4}$ from part(a) 2nd M1 rearranging their equation correctly to form a 3TQ with attempt to solve. If equation or answer is incorrect then the method to solve it must be shown. Allow one sign error 1st A1 $p = \frac{16}{25}$ or 0.64 seen 2nd A1 awrt 0.545 needs to have rejected any other solutions. Must be seen as answer to part(b) **NB** $4p(1-p) = 0.96$ leading to 0.6 is M0M1A0A0
(c)	M1 ft their value of p ($0 < p < 1$). For a ratio in the form $\frac{4'\text{their } p'^3(1-'\text{their } p')}{q}$ where $0 < q < 1$ Need to see working if incorrect answer. Can be awarded even if leads to answer > 1. Allow in terms of p eg $\frac{4p^3(1-p)}{p^3(4-3p)}$ or $\frac{4(1-p)}{(4-3p)}$ Allow with "their p" substituted. A1 awrt 0.692 allow awrt 0.693

For A1 cso: Use as guidance to check for cso and required equivalent working eg may use $1-2p+p^2$ instead of $(1-p)^2$

X ~B(4,p)

Need to see the ticked lines and at least one of the * lines (oe) as the intermediate working

$$\begin{aligned}
\mathrm{P}(X>2) &= 1-\mathrm{P}(X=0)-\mathrm{P}(X=1)-\mathrm{P}(X=2)\\
&= 1-(1-p)^4-4p(1-p)^3-6p^2(1-p)^2 \ \checkmark\\
&= 1-\left(1-4p+6p^2-4p^3+p^4\right)-4p(1-3p+3p^2-p^3)-6p^2(1-2p+p^2) \quad *\\
&= 1-1+4p-6p^2+4p^3-p^4-4p+12p^2-12p^3+4p^4-6p^2+12p^3-6p^4 \quad *\\
&= 4p^3-3p^4 \ \checkmark\\
&= p^3(4-3p) \checkmark
\end{aligned}$$

Need to see the ticked lines and at least two of the * lines (oe) as the intermediate working

$$\begin{aligned}
\mathrm{P}(X>2) &= 1-\mathrm{P}(X=0)-\mathrm{P}(X=1)-\mathrm{P}(X=2)\\
&= 1-(1-p)^4-4p(1-p)^3-6p^2(1-p)^2 \checkmark\\
&= 1-(1-p)^2[(1-p)^2+4p(1-p)+6p^2] \quad *\\
&= 1-(1-2p+p^2)[1-2p+p^2+4p-4p^2+6p^2] \quad *\\
&= 1-(1-2p+p^2)[1+2p+3p^2] \quad *\\
&= 1-(1+2p+3p^2-2p-4p^2-6p^3+p^2+2p^3+3p^4) \checkmark\\
&= 4p^3-3p^4 \ \checkmark\\
&= p^3(4-3p) \checkmark
\end{aligned}$$

Y~ B(4,1 – p)

need to see the ticked lines and 1 line of intermediate working before answer as per original

$$\begin{aligned}
\mathrm{P}(X>2) &= \mathrm{P}(Y=0)+\mathrm{P}(Y=1)\\
&= (p)^4+4(1-p)(p)^3\\
&= p^3(p+4(1-p))\\
&= 4p^3-3p^4\\
&= p^3(4-3p)
\end{aligned}$$