Question Number	Scheme	Marks
4(a)	$\mathrm{B}\left(4,\frac{1}{6}\right)$	B1 (1)
(b)	$\mathrm{H}_0 : \mathrm{B}\left(4,\frac{1}{6}\right)$ is a good model $\quad$ $\mathrm{H}_1 : \mathrm{B}\left(4,\frac{1}{6}\right)$ is not a good model	B1
	$\mathrm{E}(X=0)=\left(\frac{5}{6}\right)^4\times 200=96.4506...$ $\quad$ $\mathrm{E}(X=1)=4\times\left(\frac{5}{6}\right)^3\times\left(\frac{1}{6}\right)\times 200=77.1604...$ $\mathrm{E}(X=2)=6\times\left(\frac{5}{6}\right)^2\times\left(\frac{1}{6}\right)^2\times 200=23.1481...$ $\mathrm{E}(X=3)=4\times\left(\frac{5}{6}\right)\times\left(\frac{1}{6}\right)^3\times 200=3.0864...$ $\quad$ $\mathrm{E}(X=4)=\left(\frac{1}{6}\right)^4\times 200=0.15432...$	M1M1A1
	O | E | $\frac{(O-E)^2}{E}$ | $\frac{O^2}{E}$ 110 | 96.45 | 1.9036… | 125.4… 64 | 77.16 | 2.2444… | 53.0… 26 | 26.39 | 0.005473… | 25.6…	M1M1
	$\sum\frac{(O-E)^2}{E}=4.153...$ or $\sum\frac{O^2}{E}-200=4.153...$	A1
	$\nu=2$ CR: $\chi^2>9.21$	B1B1ft
	Insufficient evidence that $\mathrm{B}\left(4,\frac{1}{6}\right)$ is not a good model	dA1
		(10)
(c)(i)	Use the data to estimate p/ p may not be $\frac{1}{6}$	B1
(ii)	Degrees of freedom reduced by 1 **or** critical value will decrease/critical region will increase	B1
		(2)
	Notes	**Total 13**

(a)	**B1**	binomial with n = 4 and $p=\frac{1}{6}$
(b)	**B1**	both hypotheses correct. $\mathrm{B}\left(4,\frac{1}{6}\right)$ only needs to be mentioned once. Condone H_0 : Binomial is a suitable model H_1 : Binomial is not a suitable model provided $p=\frac{1}{6}$ is seen in part (a)
	M1	a correct binomial probability seen (May be implied by a correct expected value)
	M1	a correct method to find an expected value (May be implied by a correct expected value)
	A1	At least 4 expected values correct to 3 significant figures or better
	M1	for combining (2, 3 and 4) to ensure that all expected frequencies are > 5 May be implied by awrt 4.15
	M1	for a correct method to find either $\frac{(O-E)^2}{E}$ or $\frac{O^2}{E}$ (May be implied by a correct value)

	A1	for awrt 4.15
	B1	for DoF = 2
	B1ft	for a correct CV ft their DoF [For reference $\nu = 1$: 6.635 $\nu = 3$: 11.345 $\nu = 4$: 13.277]
	dA1	Dep on 3rd M mark. For a correct conclusion. Allow Binomial is a good model
(c)(i)	**B1**	correct comment about p e.g. p will be 0.1587… (allow awrt 0.159)
(ii)	**B1**	correct comment about the **reduction** in DOF oe e.g. Degrees of freedom will decrease. Allow DOF = 1 if DOF was 2 in their test or a correct comments about the critical value/critical region Allow CV = 6.635 if CV was 9.210 in their test