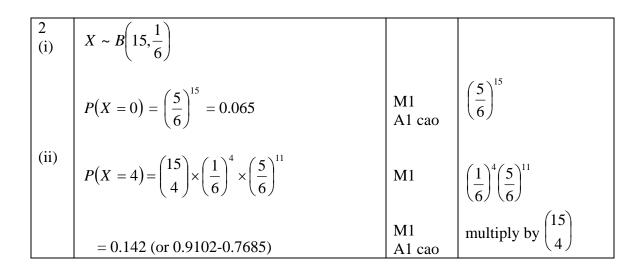
1	$X \sim B(10, 0.2)$		
(i)	$P(X < 4) = P(X \le 3) = 0.8791$	M1 for $X \le 3$	
	OR attempt to sum $P(X = 0, 1, 2, 3)$ using $X \sim$	A1	
	<i>B</i> (10,0.2) can score M1, A1		2
(ii)	Let p = the probability that a bowl is imperfect	B1 Definition of <i>p</i>	
	$H_0: p = 0.2$ $H_1: p < 0.2$	B1, B1	3
	$X \sim B(20,0.2)$ P(X \le 3) = 0.2061 0.2061 > 5% Cannot reject H ₀ and so insufficient evidence to claim a reduction.	B1 for 0.2061 seen M1 for this comparison A1 <i>dep</i> for comment <u>in context</u>	
	OR using critical region method: CR is {0} B1, 2 not in CR M1, A1 as above		3
		TOTAL	8



(iii)	$P(X > 3) = 1 - P(X \le 3)$ $= 1 - 0.7685 = 0.232$	M1 A1	
(iv)		B1	Definition of p
(A)	Let p = probability of a six on any throw $H_0: p = \frac{1}{6}$ $H_1: p < \frac{1}{6}$	B1	Both hypotheses
	$X \sim B\left(15, \frac{1}{6}\right)$ $P(X = 0) = 0.065$ $0.065 < 0.1 \text{ and so reject } H_0$ Conclude that there is sufficient evidence at the 10% level that the dice are biased against sixes.	M1 M1 dep E1 dep B1	0.065 Comparison
(<i>B</i>)	Let p = probability of a six on any throw $H_0: p = \frac{1}{6}$ $H_1: p > \frac{1}{6}$	DI	Both hypotheses
	$X \sim B\left(15, \frac{1}{6}\right)$	M1 M1 dep	0.09 Comparison
	$P(X \ge 5) = 1 - P(X \le 4) = 1 - 0.910 = 0.09$ 0.09 < 0.1 and so reject H_0 Conclude that there is sufficient evidence at the 10% level that the dice are biased in favour of sixes.	M1 dep E1 dep E1 E1	Comparison Contradictory By chance
(v)	Conclusions contradictory. Even if null hypothesis is true, it will be rejected 10% of the time purely by chance. Or other sensible comments.		

3	Number not turning up $X \sim B(16, 0.2)$		
(i)	$P(X=0) = 0.8^{16} = 0.0281$	M1 A1	0.8^{16} or tables
(ii)	$P(X > 3) = 1 - P(X \le 3) \text{ or } P(X \le 12)$ = 1 - 0.5981 = 0.4019	M1 M1 A1	Manipulation Use of tables
(iii)	$X \sim B(17, 0.2) \rightarrow P(X \ge 1) = 0.9775$	M1 A1	B(17,0.2) 0.9775
	Greater than 0.9 so acceptable	E1	
(iv)	$X \sim B(18, 0.2) \rightarrow P(X \ge 2) = 0.9009$	M1 A1	18 and ≥ 2 0.9009
	Can make 18 appointments $X \sim B(19, 0.2) \rightarrow P(X \ge 3) = 0.7631$	A1 M1	18 ok $19 \text{ and } \ge 3$
(v)	Now $X \sim B(20,p)$ Let p be probability of not turning up. $H_0: p = 0.2$ $H_1: p \neq 0.2$	B1 B1 B1	
	$P(X \le 1) = 0.0692 > 2.5\%$ cannot reject H ₀ conclude that the proportion of patients not turning up is unchanged.	M1 M1 A1 E1	0.0692 correct comparison cannot reject H ₀