Question		on	Answer	Marks	AOs		Guidance
12	(a)		2p + q + 0.2 + 0.3 = 1 soi oe	B1	2.1		
			$2 \times p \times q = 0.06$ soi	M1	3.1 a	allow M1 if 2 omitted	
			eliminate p or q with a correct substitution from one of <i>their</i> equations	M1	1.1		
			$q^2 - 0.5q + 0.06 = 0$ or $2p^2 - 0.5p + 0.03 = 0$ oe	A1	1.1	eg 2 × $\frac{0.03}{q}$ + q = 0.5 or 2p + $\frac{0.03}{p}$ = 0.5	NB if 2 omitted, A0 for $2p^2 - 0.5p + 0.6 = 0$ or $2q^2 + q + 0.24 = 0$ which have no real roots
			q = 0.2 or 0.3 and p = 0.15 or 0.1	A1	1.1	may be implied by eg q = 0.2 or 0.3 and $2p = 0.3$ or 0.2	
			(q < 2p so) q = 0.2 and p = 0.15	A1	3.2a		
				[6]			
12	(b)		$10 \times q \times (1-q)^9$ soi	M1	1.1		
			0.27 or 0.268 or awrt 0.2684 isw	A1 [2]	1.1	FT <i>their</i> q where $0 < q < 1$	

12(c) $H_0: p = 0.2$ $H_1: p > 0.2$ p is the probability that the spinner shows a 1 (on any given spin) oeB11.1 solution of the spinner shows a 1 (on any given spin) oeallow any parameter as long as clearly defined as probabilityuse of $X \sim B(100, 0.2)$ where x is the number of 1s obtained in 100 spins to obtain $P(X \ge k)$ or $P(X \le k)$ $P(X \le 27) = awrt 0.97$ M13.3 A $k = 27, 28 \text{ or } 29$ M0 for $P(X = k)$ NB $P(X = 28) = 0.014P(X = 27) = 0.020168P(X \le 27) = awrt 0.97or P(X \ge 28) = awrt 0.0340.034 < 0.05 \text{ or } 0.97 > 0.95M13.4or 28 is in critical regionFT their probabilitydependent on award of firstM1significant or reject H_0 or accept H_1; may beembedded in conclusion in contextA11.1must have the correct probability orcorrect critical region for the last twoA marksdo not allow eg conclude /prove / indicate or otherassertive statement instead ofsuggest; A0 if answer spoile0.2P(X = 10 + 10)P(X = 20)P(X = 10 + 10)P(X = 10 + 10)P(X = 10 + 10)P(X = 10 + 10)P(X = 20)P(X = 10 + 10)P(X = 10 + 10)P(X = 10 + 10)P(X = 10 + 10)P(X = 21) = awrt 0.034P(X = 10 + 10)P(X = 10 $	Question		on	Answer	Marks	AOs		Guidance
H: $p > 0.2$ words or eg P(1) = 0.2actually defined as probability p is the probability that the spinner shows a 1 (on any given spin) oeB12.5 p <	12	(c)		$H_0: p = 0.2$	B1	1.1	both hypotheses; allow equivalent in	allow any parameter as long
p is the probability that the spinner shows a 1 (on any given spin) oe use of $X \sim B(100,0.2)$ where x is the number of 1s obtained in 100 spins to obtain $P(X \ge k)$ or $P(X \le k)$ $P(X \le 27) = awrt 0.97$ M1 3.3 $k = 27, 28 \text{ or } 29$ M0 for $P(X = k)$ NB $P(X = 28) = 0.014$ $P(X = 27) = 0.020168$ $P(X \le 27) = awrt 0.97$ or $P(X \ge 28) = awrt 0.034$ $0.034 < 0.05 \text{ or } 0.97 > 0.95$ M1 3.4 or 28 is in critical regionFT their probability, dependent on award of first M1significant or reject H_0 or accept H_1 ; may be embedded in conclusion in contextA11.1must have the correct probability or correct critical region for the last two A marksFT their probability, dependent on award of first M1there is sufficient evidence to suggest (at 5% level) that the probability of a score of 1 is greater than 0.2 A12.2bImage: A1 amarks[7][7][7]Image: A1 amarksSignificant or reject H_0 if answer spoile				$H_1: p > 0.2$			words or eg $P(1) = 0.2$	probability
use of $X \sim B(100, 0.2)$ where x is the number of 1s obtained in 100 spins to obtain $P(X \ge k)$ or $P(X \le k)$ $P(X \le 27) = awrt 0.97$ M13.3 $k = 27, 28 \text{ or } 29$ M0 for $P(X = k)$ NB $P(X = 28) = 0.014P(X \ge 28) = awrt 0.034or P(X \ge 28) = awrt 0.0340.034 < 0.05 \text{ or } 0.97 > 0.95A11.1or critical region is X \ge 28FT their probability,dependent on award of firstM1significant or reject H0 or accept H1; may beembedded in conclusion in contextA11.1must have the correct probability orcorrect critical region for the last twoA marksFT their or bability,dependent on award of firstM1there is sufficient evidence to suggest (at 5% level)that the probability of a score of 1 is greater than0.2A12.2band the probability of a score of 1 is greater thanoutput to the probability of a score of 1 is greater thanA12.2band the probability of a score of 1 is greater than0.2[7]Image: Constant or constant of the probability of a score of 1 is greater thanA12.2band the probability of a score of 1 is greater than$				<i>p</i> is the probability that the spinner shows a 1 (on any given spin) oe	B 1	2.5		
P($X \le 27$) = awrt 0.97 or P($X \ge 28$) = awrt 0.034 0.034 < 0.05 or 0.97 > 0.95A11.1 or critical region is $X \ge 28$ or 28 is in critical regionP($X = 27$) = 0.020168 FT their probability, dependent on award of first M1significant or reject H ₀ or accept H ₁ ; may be embedded in conclusion in context there is sufficient evidence to suggest (at 5% level) that the probability of a score of 1 is greater than 0.2A11.1 correct critical region for the last two A marksP($X = 27$) = 0.020168 FT their probability, dependent on award of first M1do not allow eg conclude / prove / indicate or other assertive statement instead o suggest; A0 if answer spoileA12.2b				use of $X \sim B(100,0.2)$ where x is the number of 1s obtained in 100 spins to obtain $P(X \ge k)$ or $P(X \le k)$	M1	3.3	<i>k</i> = 27, 28 or 29	M0 for $P(X = k)$ NB $P(X = 28) = 0.014$
or $P(X \ge 28) = awrt 0.034$ MI3.4or 28 is in critical regionFT their probability, dependent on award of first MIsignificant or reject H ₀ or accept H ₁ ; may be embedded in conclusion in contextA11.1must have the correct probability or 				$P(X \le 27) = awrt \ 0.97$	A1	1.1	or critical region is $X \ge 28$	P(X=27) = 0.020168
0.034 < 0.05 or 0.97 > 0.95 M1 3.4 or 28 is in critical region FT their probability, dependent on award of first M1 significant or reject H ₀ or accept H ₁ ; may be embedded in conclusion in context A1 1.1 must have the correct probability or correct critical region for the last two A marks Here is sufficient evidence to suggest (at 5% level) that the probability of a score of 1 is greater than 0.2 A1 2.2b Image: Control = 1 is greater than 0.2 I				or $P(X \ge 28) = awrt 0.034$				
A1 1.1 must have the correct probability or correct critical region for the last two A marks there is sufficient evidence to suggest (at 5% level) that the probability of a score of 1 is greater than 0.2 A1 2.2b [7] [7] [7] [7] [7]				0.034 < 0.05 or 0.97 > 0.95	M1	3.4	or 28 is in critical region	FT <i>their</i> probability, dependent on award of first M1
there is sufficient evidence to suggest (at 5% level) that the probability of a score of 1 is greater than 0.2 A1 2.2b do not allow eg conclude / prove / indicate or other assertive statement instead or suggest; A0 if answer spoile				significant or reject H ₀ or accept H ₁ ; may be embedded in conclusion in context	A1	1.1	must have the correct probability or correct critical region for the last two A marks	
[7]				there is sufficient evidence to suggest (at 5% level) that the probability of a score of 1 is greater than 0.2	A1	2.2b		do not allow eg conclude / prove / indicate or other assertive statement instead of
					[7]			suggest; AU if answer spoiled