

Mark Scheme

Q1.

Question Number	Marks	Scheme	
(a)		<p>Let X be the random variable the number of faulty bolts</p> $P(X \leq 2) - P(X \leq 1) = 0.0355 - 0.0076 \quad \text{or} \quad (0.3)^2 (0.7)^{18} \frac{20!}{18!2!}$ $= 0.0279 \quad \quad \quad = 0.0278$	<p>M1</p> <p>A1</p> <p>(2)</p>
(b)		$1 - P(X \leq 3) = 1 - 0.1071$ $= 0.8929$ <p>or $1 - (0.3)^3 (0.7)^{17} \frac{20!}{17!3!} - (0.3)^2 (0.7)^{18} \frac{20!}{18!2!} - (0.3)(0.7)^{19} \frac{20!}{19!1!} - (0.7)^{20}$</p>	<p>M1</p> <p>A1</p> <p>(2)</p>
(c)		$\frac{10!}{4!6!} (0.8929)^6 (0.1071)^4 = 0.0140.$	<p>M1A1√A1</p> <p>(3)</p>
Notes			
(a)		<p>M1 Either attempting to use $P(X \leq 2) - P(X \leq 1)$</p> <p>or attempt to use binomial and find $p(X=2)$. Must have $(p)^2 (1-p)^{18} \frac{20!}{18!2!}$, with a value of p</p> <p>A1 awrt 0.0278 or 0.0279.</p>	
(b)		<p>M1 Attempting to find $1 - P(X \leq 3)$</p> <p>A1 awrt 0.893</p>	
(c)		<p>M1 for $k (p)^6 (1-p)^4$. They may use any value for p and k can be any number or ${}^nC_6 p^6 (1-p)^{n-6}$</p> <p>A1√ $\frac{10!}{4!6!} (their\ part\ b)^6 (1 - their\ part\ b)^4$ may write ${}^{10}C_6$ or ${}^{10}C_4$</p> <p>A1 awrt 0.014</p>	

Q2.

Question Number	Scheme	Marks
(a)	$X \sim B(20, 0.25)$ $P(X \geq 10) = 1 - 0.9861 = 0.0139$ $P(X \leq 1) = 0.0243$ $(0 \leq) X \leq 1 \cup 10 \leq X (\leq 20)$	M1 A1 A1 A1A1 (5)
(b)	$H_0: p = 0.25$ $H_1: p < 0.25$ $X \sim B(20, 0.25)$ $P(X \leq 3) = 0.2252$ or CR $X \leq 1$ Insufficient evidence to reject H_0 , Accept H_0 , Not significant. 3 does not lie in the Critical region. No evidence that the changes to the process have reduced the percentage of defective articles (oe)	B1 M1A1 M1d A1cso (5) Total 10 marks
Notes		
(a)	M1 using $B(20, 0.25)$ may be implied by a correct CR (allow written as a probability statement) 1 st A1 awrt 0.0139 2 nd A1 awrt 0.0243 3 rd A1 $X \leq 1$ or $0 \leq X \leq 1$ or $[0, 1]$ or 0,1 or equivalent statements 4 th A1 $X \geq 10$ or $10 \leq X \leq 20$ or 10,11,12,13,14,15,16,17,18,19,20 or $[10, 20]$ or equivalent statements NB These two A marks must be for statements with X (any letter) only – not in probability statements and SC for CR written as $1 \geq X \geq 10$ gets A1 A0	
(b)	B1 both hypotheses with p 1 st M1 using $B(20, 0.25)$ and finding $P(X \leq 3)$ or $P(X \geq 4)$ may be implied by a correct CR 1 st A1 0.2252 (allow 0.7748) if not using CR or CR $X \leq 1$ or $X < 2$ 2 nd M1 dependent on previous M being awarded. A correct statement (do not allow if there are contradicting non contextual statements) A1cso Conclusion must contain the words changes/new process oe, reduced oe number/percentage oe, and defective articles/defectives . There must be no incorrect working seen.	

www.onlinemathsteaching.co.uk

Q4.

Qu	Scheme	Marks	AO
(a)	Let N = the number of games Naasir wins $N \sim B(15, \frac{1}{3})$	M1	3.3
(i)	$P(N=2) = 0.059946\dots$ awrt 0.0599	A1	1.1b
(ii)	$P(N > 5) = 1 - P(N \leq 5) = 0.38162\dots$ awrt 0.382	A1	1.1b
		(3)	
(b)	$H_0: p = \frac{1}{3}$ $H_1: p > \frac{1}{3}$	B1	2.5
	Let X = the number of games Naasir wins $X \sim B(32, \frac{1}{3})$	M1	3.3
	$P(X \geq 16) = 1 - P(X \leq 15) = 0.03765$ (< 0.05)	A1	3.4
	[Significant result so reject H_0 (the null model) and conclude:] There is evidence to support Naasir's claim (o.e.)	A1	3.5a
		(4)	
		(7 marks)	

	Notes
(a)	<p>M1 for selecting a binomial model with correct n and p Award for sight of $B(15, \frac{1}{3})$ (o.e. e.g. in words) or implied by 1 correct answer</p> <p>1st A1 for awrt 0.0599 (from a calculator). Allow 0.05995</p> <p>2nd A1 for awrt 0.382 (from a calculator)</p>
(b)	<p>B1 for correctly stating both hypotheses in terms of p or π Accept $p = 0.\dot{3}$ or any exact equivalent. $H_1: p \geq \frac{1}{3}$ is B0</p> <p>M1 for selecting a suitable model to use for the test. Award for sight of $B(32, \frac{1}{3})$ (o.e. e.g. in words) or implied by 0.03765 Can also allow M1 for $P(X \leq 15) = 0.962$ or better or $P(X \leq 14) = 0.922$ or better</p> <p>1st A1 for use of the model to calculate an appropriate probability using calc. Sight of $P(X \geq 16)$ and answer awrt 0.0377</p>
ALT	<p>CR May use CR so award 1st A1 for CR of $X \geq 16$ must have seen some probabilities though: 1 of $P(X \leq 15) = 0.9623$ or $P(X \leq 14) = 0.9224$ or 0.9223</p> <p>2nd A1 for conclusion in context that there is support for Naasir's claim Must mention "<u>Naasir</u>" or "<u>his</u>" and "<u>claim</u>" or "<u>method</u>" (o.e.) or e.g. <u>probability of winning a game is $> \frac{1}{3}$</u> or has <u>increased</u></p> <p>Dependent on M1 and 1st A1 but can ignore hypotheses but see below If you see $P(X \geq 16) = 0.0376$ followed by a correct contextualised conclusion then please award A0A1</p>
SC	<p>Use of 0.3 for $\frac{1}{3}$ If used 0.3 instead of $\frac{1}{3}$ in (a) and score M0A0A0 can condone use of 0.3 in (b)</p> <p>1st A1 ft needs $P(X \geq 16) = 0.0138$ or CR of $X \geq 15$ and sight of 1 of $P(X \geq 15) = 0.0327$ or $P(X \geq 14) = 0.0694$</p> <p>2nd A1 as before with 0.3 instead $\frac{1}{3}$ (if appropriate)</p>

Q5.

Qu	Scheme	Mark	AO
(a)	$[D = \text{number of bags that are damp}] \quad D \sim B(35, 0.08) \quad \text{NB } 0.08 = \frac{2}{25}$	M1	3.3
(i)	$P(D = 2) = 0.2430497... \quad \text{awrt } \underline{0.243}$	A1	3.4
(ii)	$P(D > 3) = [1 - P(D \leq 3) = 1 - 0.69397...] = 0.30602... \quad \text{awrt } \underline{0.306}$	A1	1.1b
		(3)	
(b)	$H_0 : p = 0.08 \quad H_1 : p < 0.08$	B1	2.5
	$[X \sim] B(70, 0.08)$	M1	2.1
	$[P(X \leq 2)] = 0.0739756... \quad \text{awrt } \underline{0.074}$	A1	1.1b
	$[0.074 < 0.10 \text{ so significant, reject } H_0 \text{ so...}]$		
	there <u>is</u> evidence to <u>support</u> supplier <u>B's claim</u> (o.e.)	A1	2.2b
		(4)	
		(7 marks)	
Notes			
(a)	M1 for selecting a correct model: sight of or use of $B(35, 0.08)$ [Condone $B(0.08, 35)$] May be implied by one correct answer or sight of $P(D \leq 3) = \text{awrt } 0.694$ (or allow 0.693) or seeing $\binom{35}{2} 0.08^2 \times (1 - 0.08)^{35-2}$ Saying $B(35, 8\%)$ without a correct calculation would score M0		
(i)	1 st A1 for awrt 0.243		
(ii)	2 nd A1 for awrt 0.306 (Condone poor use of notation e.g. $P(D = 3) = 0.306...$ i.e. just mark ans)		
NB	$P(D \leq 3) = 0.539$ scores 2 nd A0 but would of course score M1		
(b)	B1 for both hypotheses correct in terms of p or π [Condone 8% for 0.08] M1 for sight or correct use of $B(70, 0.08)$ [Condone $B(0.08, 70)$] May be implied by prob of 0.074 or better		
	1 st A1 for final answer awrt 0.074 can condone poor notation e.g. $P(X = 2) = \text{awrt } 0.074$ Can allow this mark for CR of $X \leq 2$ provided $[P(X \leq 2)] = 0.074$ (or better) is seen [Can allow 0.07 if $X \sim B(70, 0.08)$ and $P(X \leq 2)$ are both seen]		
	2 nd A1 (dep on M1A1 but independent of hypotheses) for a correct inference in context Must mention <u>claim</u> or <u>B</u> and idea of <u>support for</u> ... or <u>proportion/probability</u> (of damp bags) and idea of <u>less</u> than 8% or <u>A</u> 2 nd A0 for contradictory statements e.g. "accept H_0 so evidence to support B's claim" 2 nd A0 if you see $0.0739... < 0.08$ so significant/ reject H_0 etc		
MR	0.8 for 0.08 In (a) allow M1 for $B(35, 0.8)$ then A0A0 In (b) allow B1 for Hypotheses and M1 for $B(70, 0.8)$ seen, then A0A0		