

7 (a)	$X \sim B(10, p)$	Binomial (10, 0.75)	B1, B1 (2)
(b)	$P(X = 6) = 0.9219 - 0.7759$ $= 0.1460$	$P(X \leq 6) - P(X \leq 5)$ 0.1460	M1 A1 (2)
(c)	$H_0: p = 0.75$ (or $p = 0.25$) $H_1: p < 0.75$ (or $p > 0.25$) Under H_0 , $X \sim B(20, 0.75)$ (or $Y \sim B(20, 0.25)$)	Correct H_0 One tailed H_1 Implied	B1 B1 B1
	$P(X \leq 13) = 1 - 0.7858 = 0.2142$ (or $P(Y \geq 7)$) Insufficient evidence to reject H_0 as $0.2412 > 0.05$ Doctor's belief is not supported by the sample	$P(X \leq 13)$ and $1 -$, 0.2142	M1, A1
	(OR CR $P(X \leq 12) = 1 - 0.8982 = 0.1018$ (or $P(Y \geq 8)$) $P(X \leq 11) = 1 - 0.9591 = 0.0409$ (or $P(Y \geq 9)$) <i>13 outside critical region</i> (or 7))	Context	A1 (6)
(d)	$P(X \leq c) \leq 0.01$ for $p=0.75$ (or $P(Y \geq 20-c) \leq 0.01$ for $p=0.25$) $P(X \leq 9) = 1 - 0.9961 = 0.0039$ (or $P(Y \geq 11)$) $P(X \leq 10) = 1 - 0.9861 = 0.0139$ (or $P(Y \geq 10)$) C. R. is $[0,9]$, so greatest no. of patients is 9.	0.9961 or 0.9981 9	M1 A1 B1 B1 (4)
			Total 14

Question Number	Scheme	Marks
7.a)	<p>Let X represent the number of bowls with minor defects.</p> <p>$\therefore X \sim B; (25, 0.20)$ may be implied</p> <p>$P(X \leq 1) = 0.0274$ or $P(X = 0) = 0.0038$ need to see at least one. prob for $X \leq$ no For M1</p> <p>$P(X \leq 9) = 0.9827; \Rightarrow P(X \geq 10) = 0.0173$ either</p> <p>\therefore CR is $\{X \leq 1 \cup X \geq 10\}$</p>	<p>B1; B1</p> <p>M1A1</p> <p>A1</p> <p>A1</p> <p>(6)</p>
b)	<p>Significance level = $0.0274 + 0.0173$</p> <p>= 0.0447 or 4.477% awrt 0.0447</p>	<p>B1</p> <p>(1)</p>
c)	<p>$H_0 : p = 0.20; H_1 : p < 0.20;$</p> <p>Let Y represent number of bowls with minor defects</p> <p>Under $H_0 Y \sim B(20, 0.20)$ may be implied</p> <p>$P(Y \leq 2)$ or $P(Y \leq 2) = 0.2061$ either</p> <p>$P(Y \leq 1) = 0.0692$</p> <p>= 0.2061 CR $Y \leq 1$ A1</p> <p>$0.2061 > 0.10$ or $0.7939 < 0.9$ or $2 > 1$ their p M1</p> <p>Insufficient evidence to suggest that the proportion of defective bowls has decreased.</p>	<p>B1 B1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>B1\sqrt</p> <p>(7)</p>

Question Number	Scheme	Marks			
6	<p><u>One tail test</u> <u>Method 1</u> $H_0 : p = 0.2$ $H_1 : p > 0.2$</p> <p>$X \sim B(5, 0.2)$ may be implied</p> <table border="0" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%; border-right: 1px solid black; padding: 5px;">$P(X \geq 3) = 1 - P(X \leq 2)$ $= 1 - 0.9421$ $= 0.0579$</td> <td style="width: 33%; padding: 5px;">$[P(X \geq 3) = 1 - 0.9421 = 0.0579]$ att $P(X \geq 3)$ $P(X \geq 4) = 1 - 0.9933 = 0.0067$ CR $X \geq 4$ awrt 0.0579</td> <td style="width: 33%; padding: 5px;">$P(X \geq 4)$</td> </tr> </table> <p>$0.0579 > 0.05$ $3 \leq 4$ or 3 is not in critical region or 3 is not significant</p> <p>(Do not reject H_0.) There is insufficient evidence at the 5% significance level that there is an increase in the number of times <u>the taxi/driver is late.</u> Or Linda's claim is not justified</p>	$P(X \geq 3) = 1 - P(X \leq 2)$ $= 1 - 0.9421$ $= 0.0579$	$[P(X \geq 3) = 1 - 0.9421 = 0.0579]$ att $P(X \geq 3)$ $P(X \geq 4) = 1 - 0.9933 = 0.0067$ CR $X \geq 4$ awrt 0.0579	$P(X \geq 4)$	<p>B1 B1 M1 M1 A1 M1 B1</p> <p style="text-align: right;">(7) Total 7</p>
$P(X \geq 3) = 1 - P(X \leq 2)$ $= 1 - 0.9421$ $= 0.0579$	$[P(X \geq 3) = 1 - 0.9421 = 0.0579]$ att $P(X \geq 3)$ $P(X \geq 4) = 1 - 0.9933 = 0.0067$ CR $X \geq 4$ awrt 0.0579	$P(X \geq 4)$			
	<p><u>Method 2</u> $H_0 : p = 0.2$ $H_1 : p > 0.2$</p> <p>$X \sim B(5, 0.2)$ may be implied</p> <table border="0" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%; border-right: 1px solid black; padding: 5px;">$P(X < 3) =$ 0.9421</td> <td style="width: 33%; padding: 5px;">$[P(X < 3) = 0.9421]$ att $P(X < 3)$ $P(X < 4) = 0.9933$ CR $X \geq 4$ awrt 0.942</td> <td style="width: 33%; padding: 5px;">$P(X < 4)$</td> </tr> </table> <p>$0.9421 < 0.95$ $3 \leq 4$ or 3 is not in critical region or 3 is not significant</p> <p>(Do not reject H_0.) There is insufficient evidence at the 5% significance level that there is an increase in the number of times <u>the taxi/driver is late.</u> Or Linda's claim is not justified</p>	$P(X < 3) =$ 0.9421	$[P(X < 3) = 0.9421]$ att $P(X < 3)$ $P(X < 4) = 0.9933$ CR $X \geq 4$ awrt 0.942	$P(X < 4)$	<p>B1 B1 M1 M1A1 M1 B1</p> <p style="text-align: right;">(7)</p>
$P(X < 3) =$ 0.9421	$[P(X < 3) = 0.9421]$ att $P(X < 3)$ $P(X < 4) = 0.9933$ CR $X \geq 4$ awrt 0.942	$P(X < 4)$			

<p><u>Two tail test</u> <u>Method 1</u> $H_0 : p = 0.2$ $H_1 : p \neq 0.2$</p> <p>$X \sim X \sim B(5, 0.2)$ may be implied</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%; border-right: 1px solid black; padding: 5px;"> $P(X \geq 3) = 1 - P(X \leq 2)$ $= 1 - 0.9421$ $= 0.0579$ </td> <td style="width: 33%; padding: 5px;"> $[P(X \geq 3) = 1 - 0.9421 = 0.0579]$ att $P(X \geq 3)$ $P(X \geq 4) = 1 - 0.9933 = 0.0067$ $CR X \geq 4$ awrt 0.0579 </td> <td style="width: 33%; padding: 5px;"> $P(X \geq 4)$ </td> </tr> </table> <p>$0.0579 > 0.025$ $3 \leq 4$ or 3 is not in critical region or 3 is not significant</p> <p>(Do not reject H_0.) There is insufficient evidence at the 5% significance level that there is an increase in the number of times the <u>taxi/driver is late</u>. Or Linda's claim is not justified</p>	$P(X \geq 3) = 1 - P(X \leq 2)$ $= 1 - 0.9421$ $= 0.0579$	$[P(X \geq 3) = 1 - 0.9421 = 0.0579]$ att $P(X \geq 3)$ $P(X \geq 4) = 1 - 0.9933 = 0.0067$ $CR X \geq 4$ awrt 0.0579	$P(X \geq 4)$	<p>B1 B0</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>B1</p> <p>(7)</p>
$P(X \geq 3) = 1 - P(X \leq 2)$ $= 1 - 0.9421$ $= 0.0579$	$[P(X \geq 3) = 1 - 0.9421 = 0.0579]$ att $P(X \geq 3)$ $P(X \geq 4) = 1 - 0.9933 = 0.0067$ $CR X \geq 4$ awrt 0.0579	$P(X \geq 4)$		
<p><u>Method 2</u> $H_0 : p = 0.2$ $H_1 : p \neq 0.2$</p> <p>$X \sim X \sim B(5, 0.2)$ may be implied</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%; border-right: 1px solid black; padding: 5px;"> $P(X < 3) =$ 0.9421 </td> <td style="width: 33%; padding: 5px;"> $[P(X < 3) = 0.9421]$ att $P(X < 3)$ $P(X < 4) = 0.9933$ $CR X \geq 4$ awrt 0.942 </td> <td style="width: 33%; padding: 5px;"> $P(X < 4)$ </td> </tr> </table> <p>$0.9421 < 0.975$ $3 \leq 4$ or 3 is not in critical region or 3 is not significant</p> <p>Do not reject H_0. There is insufficient evidence at the 5% significance level that there is an increase in the number of times <u>the taxi/driver is late</u>. Or Linda's claim is not justified</p>	$P(X < 3) =$ 0.9421	$[P(X < 3) = 0.9421]$ att $P(X < 3)$ $P(X < 4) = 0.9933$ $CR X \geq 4$ awrt 0.942	$P(X < 4)$	<p>B1 B0</p> <p>M1</p> <p>M1A1</p> <p>M1</p> <p>B1</p> <p>(7)</p>
$P(X < 3) =$ 0.9421	$[P(X < 3) = 0.9421]$ att $P(X < 3)$ $P(X < 4) = 0.9933$ $CR X \geq 4$ awrt 0.942	$P(X < 4)$		
<p><u>Special Case</u></p> <p>If they use a probability of $\frac{1}{7}$ throughout the question they may gain B1 B1 M0 M1 A0 M1 B1.</p> <p>NB they must attempt to work out the probabilities using $\frac{1}{7}$</p>				

Question Number	Scheme	Marks
5(a)	$X \sim B(15, 0.5)$	B1 B1 (2)
(b)	$P(X = 8) = P(X \leq 8) - P(X \leq 7) \quad \text{or} \quad \left(\frac{15!}{8!7!} (p)^8 (1-p)^7 \right)$ $= 0.6964 - 0.5$ $= 0.1964$	M1 A1 awrt 0.196 (2)
(c)	$P(X \geq 4) = 1 - P(X \leq 3)$ $= 1 - 0.0176$ $= 0.9824$	M1 A1 (2)
(d)	$H_0 : p = 0.5$ $H_1 : p > 0.5$ $X \sim B(15, 0.5)$ $P(X \geq 13) = 1 - P(X \leq 12)$ $= 1 - 0.9963$ $= 0.0037$ $0.0037 < 0.01$ $[P(X \geq 12) = 1 - 0.9824 = 0.0176] \quad \text{att } P(X \geq 13)$ $P(X \geq 13) = 1 - 0.9963 = 0.0037$ $\text{CR } X \geq 13 \quad \text{awrt } 0.0037 / \text{CR } X \geq 13$ $13 \geq 13$ Reject H_0 or it is significant or a correct statement in context from their values There is sufficient evidence at the 1% significance level that the coin is <u>biased in favour of heads</u> Or There is evidence that Sues belief is correct	B1 B1 M1 A1 M1 A1 (6)
	<u>Notes</u> (a) B1 for Binomial B1 for 15 and 0.5 must be in part a This need not be in the form written (b) M1 attempt to find $P(X = 8)$ any method. Any value of p A1 awrt 0.196 Answer only full marks (c) M1 for $1 - P(X \leq 3)$. A1 awrt 0.982	

- (d) B1 for correct H_0 . must use p or π
B1 for correct H_1 must be one tail must use p or π
M1 attempt to find $P(X \geq 13)$ correctly. E.g. $1 - P(X \leq 12)$
A1 correct probability or CR

To get the next 2 marks the null hypothesis must state or imply that $(p) = 0.5$

M1 for correct statement based on their probability or critical region or a correct contextualised statement that implies that. not just 13 is in the critical region.

A1 This depends on their M1 being awarded for rejecting H_0 . Conclusion in context. Must use the words biased in favour of heads or biased against tails or sues belief is correct .

NB this is a B mark on EPEN.

They may also attempt to find $P(X < 13) = 0.9963$ and compare with 0.99

Question Number	Scheme	Marks
Q4 (a)	$X \sim B(20, 0.3)$ $P(X \leq 9) = 0.9520$ so Therefore the critical region is $\{X \leq 2\} \cup \{X \geq 10\}$ (b) $0.0355 + 0.0480 = 0.0835$ awrt (0.083 or 0.084) (c) 11 is in the critical region there is evidence of a <u>change/ increase</u> in the <u>proportion/number</u> of <u>customers buying single tins</u>	M1 A1 A1 A1A1 (5) B1 (1) B1ft B1ft (2) [8]
(a)	M1 for B(20,0.3) seen or used 1 st A1 for 0.0355 2 nd A1 for 0.048 3 rd A1 for $(X) \leq 2$ or $(X) < 3$ or $[0,2]$ They get A0 if they write $P(X \leq 2/ X < 3)$ 4 th A1 $(X) \geq 10$ or $(X) > 9$ or $[10,20]$ They get A0 if they write $P(X \geq 10/ X > 9)$ $10 \leq X \leq 2$ etc is accepted To describe the critical regions they can use any letter or no letter at all. It does not have to be X. (b) B1 correct answer only (c) 1 st B1 for a correct statement about 11 and their critical region. 2 nd B1 for a correct comment in context consistent with their CR and the value 11 Alternative solution 1 st B0 $P(X \geq 11) = 1 - 0.9829 = 0.0171$ since no comment about the critical region 2 nd B1 a correct contextual statement.	