1. (a) The set of values of the test statistic for which the null hypothesis is rejected in a hypothesis test.	B1 B1	2
Note **1st B1** for **"values/ numbers"** **2nd B1** for "reject the null hypothesis" o.e or the test is significant		
(b) $X \sim B(30,0.3)$	M1	
$P(X \le 3) = 0.0093$		
$P(X \le 2) = 0.0021$	A1	
$P(X \ge 16) = 1 - 0.9936 = 0.0064$		
$P(X \ge 17) = 1 - 0.9979 = 0.0021$	A1	
Critical region is $(0 \le) x \le 2$ or $16 \le x (\le 30)$	A1A1	5
Note **M1** for using B(30,0.3) **1st A1** $P(X \le 2) = 0.0021$ **2nd A1** 0.0064 **3rd A1** for $(X) \le 2$ or $(X) < 3$ They get **A0** if they write **P**$(X \le 2$ $X \le 3)$ **4th A1** $(X) \ge 16$ or $(X) > 15$ They get **A0** if they write **P**$(X \ge 16$ $X \ge 15$ **NB these are B1 B1 but mark as A1 A1** $16 \le X \le 2$ 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*.		
(c) Actual significance level 0.0021+0.0064=0.0085 or 0.85%	B1	1
Note **B1** correct answer only		
(d) 15 (it) is not in the critical region not significant No significant evidence of a change in $P = 0.3$ accept H_0, (reject H_1) $P(x \ge 15) = 0.0169$	Bft 2, 1, 0	2
Note Follow through 15 and their critical region **B1** for any one of the 5 correct statements up to a maximum of B2 **– B1** for any incorrect statements		

Question Number	Scheme	Marks
2 (a)	$X \sim \mathrm{B}(15, 0.5)$	B1 B1 (2)
(b)	$\mathrm{P}(X=8) = \mathrm{P}(X \le 8) - \mathrm{P}(X \le 7)$ or $\left(\frac{15!}{8!7!}(p)^8(1-p)^7\right)$	M1
	$= 0.6964 - 0.5$	
	$= 0.1964$ awrt 0.196	A1 (2)
(c)	$\mathrm{P}(X \ge 4) = 1 - \mathrm{P}(X \le 3)$	M1
	$= 1 - 0.0176$	
	$= 0.9824$	A1 (2)
(d)	$\mathrm{H}_0 : p = 0.5$	B1
	$\mathrm{H}_1 : p > 0.5$	B1
	$X \sim \mathrm{B}(15, 0.5)$	
	$\mathrm{P}(X \ge 13) = 1 - \mathrm{P}(X \le 12)$ | $[\mathrm{P}(X \ge 12) = 1 - 0.9824 = 0.0176]$ att $\mathrm{P}(X \ge 13)$	M1
	$= 1 - 0.9963$ | $\mathrm{P}(X \ge 13) = 1 - 0.9963 = 0.0037$	
	$= 0.0037$ | CR $X \ge 13$ awrt 0.0037/ CR $X \ge 13$	A1
	$0.0037 < 0.01$ | $13 \ge 13$	
	Reject H_0 or it is significant or a correct statement in context from their values	M1
	There is sufficient evidence at the 1% significance level that the coin is biased in favour of heads *or* There is evidence that Sue's belief is correct	A1 (6)
		(12 marks)

Question Number	Scheme	Marks
Q3 (a)	The set of values of the test statistic for which the null hypothesis is rejected in a hypothesis test.	B1 B1 (2)
(b)	$X \sim \text{B}(30, 0.3)$ $\text{P}(X \le 3) = 0.0093$ $\text{P}(X \le 2) = 0.0021$ $\text{P}(X \ge 16) = 1 - 0.9936 = 0.0064$ $\text{P}(X \ge 17) = 1 - 0.9979 = 0.0021$ Critical region is $(0 \le) x \le 2$ or $16 \le x (\le 30)$	M1 A1 A1 A1A1 (5)
(c)	Actual significance level 0.0021+0.0064=0.0085 or 0.85%	B1 (1)
(d)	15 (it) is not in the critical region not significant No significant evidence of a change in $p = 0.3$ accept H_0, (reject H_1) $\text{P}(x \ge 15) = 0.0169$	Bft 2, 1, 0 (2)
		Total [10]

4.	(a)	X ~ B(20, 0.3)	M1	
		P ($X \leq 2$) = 0.0355		
		P($X \geq 11$) = 1 – 0.9829 = 0.0171		
		Critical region is ($X \leq 2$) $\cup$ ($X \geq 11$)	A1 A1	3
	(b)	Significance level = 0.0355 + 0.0171, = 0.0526 or 5.26%	M1 A1	2
	(c)	Insufficient evidence to reject H_0 **Or** sufficient evidence to accept H0 /not significant	B1 ft	
		x = 3 (or the value) is not in the critical region or 0.1071> 0.025	B1 ft	2
		Do not allow inconsistent comments		
				[7]

Question Number	Scheme	
Q5 (a)	X~ B(20, 0.3)	M1
	P($X \leq 2$) = 0.0355	A1
	P($X \leq 9$) = 0.9520 so P($X \geq 10$) = 0.0480	A1
	Therefore the critical region is $\{X \leq 2\} \cup \{X \geq 10\}$	A1A1 (5)
(b)	0.0355 + 0.0480 = 0.0835 awrt (0.083 or 0.084)	B1 (1)
(c)	11 is in the critical region	B1ft
	there is evidence of a change/ increase in the proportion/number of customers <u>buying single</u> tins	B1ft)
		[8]

Question Number	Scheme	Marks
6	$H_0: p = 0.5$	B1
	$H_1: p > 0.5$	B1
	Using correct Bin	M1
	X~B(30,0.5) or P($X \leq 19$) = 0.9506	M1
	P($X \geq 21$) = 1 - P($X \leq 20$) P($X \geq 20$) = 0.0494	
	= 1 - 0.9786	
	= 0.0214 CR $X \geq 20$	A1
	so significant/rejectH_0/in Critical region	M1 dep
	Evidence to suggest **David's claim is incorrect**	A1
	or The <u>weather</u> **forecast** produced by the <u>local</u> **radio** is better than those achieved by **<u>tossing/flipping a coin</u>**	(7)
		7

7. One tail test

Method 1

H_0: p = 0.2 — B1

H_1: p > 0.2 — B1

X ~ B(5, 0.2)   may be implied — M1

P($X \geq 3$) = 1 – P($X \leq$ 2) = 1 – 0.9421	[P($X \geq 3$) = 1 – 0.9421 = 0.0579] att P($X \geq 3$) P($X \geq 4$) = 1 – 0.9933 = 0.0067	P($X \geq 4$)	M1
= 0.0579	CR $X \geq 4$ awrt 0.0579		A1
0.0579 > 0.05	3 ≤ 4 or 3 is not in critical region or 3 is not significant		

(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 taxi/driver is late. — B1   7

or

Linda's claim is not justified

8. (a)	H_0: P(6) = $^1/_6$ H_1: P(6) < $^1/_6$	**B1**	[1]	Allow H_0: $p = {}^1/_6$ H_1: $p < {}^1/_6$
(b)	$\left(\frac{5}{6}\right)^{15}$ = 0.065 > 0.05	**M1** **A1**	[2]	Correct result and comparison needed for A1 SR if 2 tail test followed allow A1 for 0.065 > 0.025
(c)	$\left(\frac{5}{6}\right)^{16} = 0.054$ and $\left(\frac{5}{6}\right)^{17} = 0.045$ Smallest n is 17 **OR** $\left(\frac{5}{6}\right)^n < 0.05$ and attempt to solve $n\ln\left(\frac{5}{6}\right) < \ln 0.05$ smallest n is 17	**M1** **A1** **M1** **A1**	[2]	both No errors seen

9. **a.** 0.0417

b. 0.0592

c. 0.0833

d. 0.1184

e. Let p = P(man selected)

H_0: p = 0.5, H_1: p =/ 0.5

P(X<4 or X>11) = 0.1184 > 5%

There is not sufficient evidence to reject H_0, so it is reasonable to suppose that the process is satisfactory

f. 4<w<11