

Hypothesis Testing - Edexcel Past Exam Questions **MARK SCHEME**
Question 1: June 05 Q7

(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 Context 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 $P(Y \geq 9)$) 13 outside critical region (or 7))		(6) either (M1 A1)
(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 2: Jan 06 Q7

7.(a)(i)	$H_0: p = 0.2, H_1: p \neq 0.2$	$p =$	B1B1
	$P(X \geq 9) = 1 - P(X \leq 8)$ $= 1 - 0.9900 = 0.01$	or attempt critical value/region CR $X \geq 9$	M1
	$0.01 < 0.025$ or $9 \geq 9$ or $0.99 > 0.975$ or $0.02 < 0.05$ or lies in interval with correct interval stated. Evidence that the percentage of pupils that read Deano is not 20%		A1 A1
(ii)	$X \sim \text{Bin}(20, 0.2)$ So 0 or $[9, 20]$ make test significant.	may be implied or seen in (i) or (ii) 0,9, between "their 9" and 20	B1 B1B1B1 (9)



Question 3: June 06 Q7

Question Number	Scheme	Marks
(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 $\{X \leq 1 \cup X \geq 10\}$ A1</p>	<p>B1; B1</p> <p>M1A1</p> <p>A1</p> <p>A1</p> <p style="text-align: right;">(6)</p>
b)	<p>Significance level = $0.0274 + 0.0173$</p> <p style="text-align: center;">$= 0.0447$ or 4.477% awrt 0.0447</p>	<p>B1</p> <p style="text-align: right;">(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 style="text-align: center;">$P(Y \leq 1) = 0.0692$</p> <p>$= 0.2061$ CR $Y \leq 1$</p> <p>$0.2061 > 0.10$ or $0.7939 < 0.9$ or $2 > 1$ their p</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[√]</p> <p style="text-align: right;">(7)</p>



Question 5: June 07 Q6

Question Number	Scheme	Marks			
	<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%;"> <tr> <td style="width: 33%; vertical-align: top;"> $P(X \geq 3) = 1 - P(X \leq 2)$ $= 1 - 0.9421$ $= 0.0579$ </td> <td style="width: 33%; vertical-align: top; border-left: 1px solid black; border-right: 1px solid black;"> $[P(X \geq 3) = 1 - 0.9421 = 0.0579]$ 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%; vertical-align: top; border-left: 1px solid black;"> $P(X \geq 4)$ </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%;"> <tr> <td style="width: 33%; vertical-align: top;"> $P(X < 3) =$ 0.9421 </td> <td style="width: 33%; vertical-align: top; border-left: 1px solid black; border-right: 1px solid black;"> $[P(X < 3) = 0.9421]$ att $P(X < 3)$ $P(X < 4) = 0.9933$ $CR X \geq 4$ awrt 0.942 </td> <td style="width: 33%; vertical-align: top; border-left: 1px solid black;"> $P(X < 4)$ </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	$P(X < 4)$			



Question 6: Jan 08 Q5

<p>-</p>	<p>$H_0 : p = 0.3; H_1 : p > 0.3$</p> <p>Let X represent the number of tomatoes greater than 4 cm : $X \sim B(40, 0.3)$</p> <p>$P(X \geq 18) = 1 - P(X \leq 17) = 0.0320$</p> <p>$P(X \geq 18) = 1 - P(X \leq 17) = 0.0320$</p> <p>$P(X \geq 17) = 1 - P(X \leq 16) = 0.0633$</p> <p>$CR X \geq 18$</p> <p>$0.0320 < 0.05$</p> <p>$18 \geq 18$ or 18 in the critical region</p> <p>no evidence to Reject H_0 or it is significant</p> <p>New fertiliser has <u>increased</u> the probability of a <u>tomato</u> being greater than 4 cm</p> <p>Or</p> <p>Dhriti's claim is true</p>	<p>B1 B1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>B1d cao (7)</p>
	<p>B1 for correct H_0 . must use p or pi</p> <p>B1 for correct H_1 must use p and be one tail.</p> <p>B1 using $B(40, 0.3)$. This may be implied by their calculation</p> <p>M1 attempt to find $1 - P(X \leq 17)$ or get a correct probability. For CR method must attempt to find $P(X \geq 18)$ or give the correct critical region</p> <p>A1 awrt 0.032 or correct CR.</p> <p>M1 correct statement based on their probability , H_1 and 0.05 or a correct contextualised statement that implies that.</p> <p>B1 this is not a follow through .conclusion in context. Must use the words increased, tomato and some reference to size or diameter. This is dependent on them getting the previous M1</p> <p>If they do a two tail test they may get B1 B0 B1 M1 A1 M1 B0</p> <p>For the second M1 they must have accept H_0 or it is not significant or a correct contextualised statement that implies that.</p>	

Question 7: June 08 Q5

Question Number	Scheme	Marks
(a)	$X \sim B(15, 0.5)$	B1 B1 (2)
(b)	$P(X=8) = P(X \leq 8) - P(X \leq 7) \text{ or } \left(\frac{15!}{8!7!} (p)^8 (1-p)^7 \right)$ $= 0.6964 - 0.5$ $= 0.1964$	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)	$H_0 : p = 0.5$ $H_1 : p > 0.5$ $X \sim B(15, 0.5)$ $P(X \geq 13) = 1 - P(X \leq 12)$ $= 1 - 0.9963$ $= 0.0037$	B1 B1 M1 A1 awrt 0.0037/ CR $X \geq 13$ M1 A1 (6)
	$0.0037 < 0.01$	
	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	
	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	

	<p>(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</p> <p>To get the next 2 marks the null hypothesis must state or imply that $(p) = 0.5$</p> <p>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.</p> <p>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.</p> <p>They may also attempt to find $P(X < 13) = 0.9963$ and compare with 0.99</p>	
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Question 8: Jan 09 Q3

Question Number	Scheme	Marks
(a)	$X \sim B(20, 0.3)$ $P(X \leq 2) = 0.0355$ $P(X \geq 11) = 1 - 0.9829 = 0.0171$ Critical region is $(X \leq 2) \cup (X \geq 11)$	M1 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 H_0 /not significant $x = 3$ (or the value) is not in the critical region or $0.1071 > 0.025$ Do not allow inconsistent comments	B1 ft B1 ft (2)

Question 9: June 09 Q4

Question Number	Scheme	Marks
(a)	$X \sim B(20, 0.3)$ $P(X \leq 9) = 0.9520$ so $P(X \geq 10) = 0.0480$ Therefore the critical region is $\{X \leq 2\} \cup \{X \geq 10\}$	M1 A1 A1 A1A1 (5)
(b)	$0.0355 + 0.0480 = 0.0835$ awrt (0.083 or 0.084)	B1 (1)
(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>	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.	

Question 10: Jan 10 Q6

Question Number	Scheme	Marks
(a)	The set of values of the test statistic for which the null hypothesis is rejected in a hypothesis test.	B1 B1 (2)
(b)	$X \sim B(30, 0.3)$ $P(X \leq 3) = 0.0093$ $P(X \leq 2) = 0.0021$ $P(X \geq 16) = 1 - 0.9936 = 0.0064$ $P(X \geq 17) = 1 - 0.9979 = 0.0021$ Critical region is $(0 \leq) x \leq 2$ or $16 \leq x (\leq 30)$	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) $P(x \geq 15) = 0.0169$	Bft 2, 1, 0 (2)
		Total [10]
<p>Notes</p> <p>(a) 1st B1 for “values/ numbers” 2nd B1 for “reject the null hypothesis” o.e or the test is significant</p> <p>(b) M1 for using B(30,0.3) 1st A1 $P(x \leq 2) = 0.0021$ 2nd A1 0.0064 3rd A1 for $(X) \leq 2$ or $(X) < 3$ They get A0 if they write $P(X \leq 2 / X < 3)$ 4th A1 $(X) \geq 16$ or $(X) > 15$ They get A0 if they write $P(X \geq 16 / X > 15)$ NB these are B1 B1 but mark as A1 A1 $16 \leq X \leq 2$ 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.</p> <p>(c) B1 correct answer only</p> <p>(d) 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</p>		

Question 11: June 10 Q6

Question Number	Scheme	Marks
(a)	2 outcomes/faulty or not faulty/success or fail A constant probability Independence Fixed number of trials (fixed n)	B1 B1 (2)
(b)	$X \sim B(50, 0.25)$ $P(X \leq 6) = 0.0194$ $P(X \leq 7) = 0.0453$ $P(X \geq 18) = 0.0551$ $P(X \geq 19) = 0.0287$ CR $X \leq 6$ and $X \geq 19$	M1 A1 A1 (3)
(c)	$0.0194 + 0.0287 = 0.0481$	M1A1 (2)
(d)	8(It) is not in the Critical region or 8(It) is not significant or $0.0916 > 0.025$; There is evidence that the probability of a faulty bolt is 0.25 or the company's claim is correct.	M1; A1ft (2)
(e)	$H_0 : p = 0.25$ $H_1 : p < 0.25$ $P(X \leq 5) = 0.0070$ or CR $X \leq 5$ $0.007 < 0.01$, 5 is in the critical region, reject H_0 , significant. There is evidence that the probability of faulty bolts has decreased	B1B1 M1A1 M1 A1ft (6) [15]
	Notes (a) B1 B1 one mark for each of any of the four statements. Give first B1 if only one correct statement given. No context needed. (b) M1 for writing or using $B(50, 0.25)$ also may be implied by both CR being correct. Condone use of P in critical region for the method mark. A1 $(X) \leq 6$ o.e. $[0, 6]$ DO NOT accept $P(X \leq 6)$ A1 $(X) \geq 19$ o.e. $[19, 50]$ DO NOT accept $P(X \geq 19)$ (c) M1 Adding two probabilities for two tails. Both probabilities must be less than 0.5 A1 awrt 0.0481 (d) M1 one of the given statements followed through from their CR. A1 contextual comment followed through from their CR. NB A correct contextual comment alone followed through from their CR will get M1 A1 (e) B1 for H_0 must use p or π (pi) B1 for H_1 must use p or π (pi) M1 for finding or writing $P(X \leq 5)$ or attempting to find a critical region or a correct critical region A1 awrt 0.007/CR $X \leq 5$ M1 correct statement using their Probability and 0.01 if one tail test or a correct statement using their Probability and 0.005 if two tail test. The 0.01 or 0.005 needn't be explicitly seen but implied by correct statement compatible with their H_1 . If no H_1 given M0 A1 correct contextual statement follow through from their prob and H_1 . Need faulty bolts and decreased. NB A correct contextual statement alone followed through from their prob and H_1 get M1 A1	

Question 12: Jan 11 Q2

Question Number	Scheme	Marks
	$H_0 : p = 0.2 \quad H_1 : p > 0.2$ Under $H_0, X \sim \text{Bin}(10, 0.2)$ $P(X \geq 4) = 1 - P(X \leq 3) \quad \text{OR} \quad P(X \leq 4) = 0.9672$ $= 1 - 0.8791 \quad P(X \geq 5) = 0.0328$ $= 0.1209 \quad \text{CR } X \geq 5$ $0.1209 > 0.05$. Insufficient evidence to reject H_0 so teacher's claim is supported.	B1 B1 M1 A1 M1A1ft [6]
Notes		
B1 for both H_0 and H_1 correct. Must use p or π (pi) B1 for writing or using $\text{Bin}(10, 0.2)$ M1 for finding or writing $1 - P(X \leq 3)$ or $P(X \leq 4) = 0.9672$ $P(X \geq 5) = 0.0328$ oe or a correct critical region A1 awrt 0.121 or $\text{CR } X \geq 5$ M1 need $p < 0.5$ and: correct statement using their Probability and 0.05 if one tail test or correct statement using their Probability and 0.025 if two tail test (condone a comparison with 0.05 instead of 0.025 for a two tail test). Do not allow non-contextual conflicting statements eg "significant" and "accept H_0 " A1ft correct contextual statement followed through from "their prob". Either a comment on whether the teacher's claim was correct or on whether the student was guessing the answers. NB if a correct contextual statement only is given for their probability then award M1 A1 If $p > 0.5$ They may compare with 0.95 (one tail method) or 0.975 (two tail method) Probability is 0.8791.		

Question 13: June 11 Q6

Question Number	Scheme	Marks
(a)	$H_0 : p = 0.15 \quad H_1 : p \neq 0.15$ $X \sim \text{B}(30, 0.15)$ $P(X \leq 1) = 0.0480 \quad \text{or CR: } X = 0$ $(0.0480 > 0.025)$ not a significant result or do not reject H_0 or not in CR there is no evidence of a <u>change</u> in the <u>proportion of customers buying an item from the display</u> .	B1 B1 M1 A1 M1 A1ft (6)