

Question	Scheme		Marks	AOs
1(a)	$H_0: p = 0.1 \quad H_1: p \neq 0.1$		B1	2.5
			(1)	
(b)	Use of $X \sim B(50, 0.1)$ implied by sight of one of awrt 0.0052 or awrt 0.9755 or awrt 0.0245		M1	3.4
	Critical regions $X = 0$ or $X \geq 10$		A1	1.1b
	$X = 0$ and $X \geq 10$ plus $P(X = 0) = \text{awrt } 0.0052$ and $P(X \geq 10) = \text{awrt } 0.0245$		A1	1.1b
	SC: Both CR correct with no probabilities and no distribution seen scores M0A1A0			
			(3)	
(c)	0.0297		B1ft	1.1b
			(1)	
(d)	15 is <u>in the critical region</u> therefore there is evidence to support the <u>manager's</u> belief		B1ft	2.2b
			(1)	
(6 marks)				
Notes				
(a)	B1	For both hypotheses in terms of p or π . Connected to H_0 and H_1 correctly Condone 10% but not 10		
(b)	M1	Using correct distribution to find the probability associated with one tail of the CR If the correct distribution is <u>stated</u> (may be seen in part(a)) allow for one tail of the correct CR or one of (awrt 0.025 or awrt 0.005 or awrt 0.975) seen connected to a correct probability statement		
	A1	Lower CR $X = 0 / X < 1 / X \leq 0 /$ [condone eg $P(X = 0)$ labelled as CR] Or Upper CR $X \geq 10$ or $X > 9$ [condone $P(X \geq 10)$ oe labelled as CR]		
	A1	Both CR's correct with the relevant probabilities Allow \cup for "and" and $X > 9, X < 1, X \leq 0$ [do not allow $P(X = 0)$ or $P(X \geq 10)$ oe] Allow CR in different form eg $(9, \infty), [10, \infty)$		
(c)	B1ft	awrt 0.0297 or 2.97% or ft for the sum of the probabilities in (b) for "their 2 critical regions" if seen. If none seen it must be awrt 0.0297 SC M0 in (b) for a one tail test Allow B1ft for their one tail CR in (b) eg 0.0338 or 0.0245 or 0.0579		
(d)	B1ft	A correct statement about 15 and "their CR" or sight $P(X \geq 15) = 0.0000738\dots$ and comparison with "their 0.0245" and a compatible correct statement in context. eg There is evidence that there has been a change in the <u>proportion/probability</u> arriving <u>late</u> Condone increase rather than change Do not allow contradicting statements. NB No CR given in (b) then B0		

Qu 2	Scheme	Marks	AO
(a)	Comment in context about either independence or random packing e.g. “ <u>prizes must be placed in packets at random/independently</u> of each other” or about constant probability e.g. “ <u>the probability of a packet containing a prize is constant/ the same/fixed</u> ”	B1 (1)	3.5b
(b)(i)	$[P(T = 6) =]$ 0.17273... awrt 0.173	B1	1.1b
(ii)	$[P(T < 3) = P(T \leq 2) =]$ 0.061587... awrt 0.0616	B1 (2)	1.1b
(c)	$[K = \text{no. of boxes with fewer than 3 packets containing a prize}]$ $K \sim B(5, \text{“0.0616”})$ $P(K = 2) = 0.031344...$ in the range [0.0313~0.0314]	M1 A1 (2)	1.1b 1.1b
(d)	$H_0 : p = \frac{1}{7}$ $H_1 : p < \frac{1}{7}$ $[X = \text{no of packets containing a prize}] X \sim B(110, \frac{1}{7})$ $[P(X \leq 9)] = 0.038292...$ $[\text{Significant result or reject } H_0]$ E.g. there <u>is</u> evidence to <u>support</u> Kamil’s <u>claim</u>	B1 M1 A1 A1 (4)	2.5 3.3 3.4 2.2b
		(9 marks)	
Notes			
(a)	B1 May use idea of independent events: a suitable reason, in context , covering idea of <u>random</u> packing or packets filled <u>independently</u> . Should mention key words/ideas of: <u>prizes in packets</u> or <u>packets in boxes</u> May use idea of constant probability. Must see key words underlined in scheme. Idea of probability with “independence” or “not affected by other packets” is B0 B0 for: Idea of only 2 cases. E.g. <u>Packet</u> contains a <u>prize</u> or not or Idea of a fixed number of trials. E.g. Need a <u>fixed</u> number of <u>packets</u> in each <u>box</u>		
(b)(i)	B1 for awrt 0.173		
(ii)	B1 for awrt 0.0616		
(c)	M1 for sight of $B(5, \text{“0.0616”})$ or ${}^5C_2 (\text{“0.0616”})^2 (1 - \text{“0.0616”})^3$ ft their answer to (b)(ii). A1 for an answer in the range [0.0313 to 0.0314] Use of 0.0616 gives 0.031356..ans only 2/2		
(d)	B1 for both hypotheses correct in terms of p or π M1 for selecting an appropriate model, may be implied by 1 st A1 or $P(X = 9) = 0.0199(2...)$ 1 st A1 for 0.038 or better or allow 0.04 with sight of $P(X \leq 9)$		
ALT	Critical Region. Allow CR of $X \leq 9$ (or $X < 10$) provided a supporting probability is seen e.g. A1 for correct CR plus $P(X \leq 10) = 0.0718...$ (accept 2sf or 1sf if prob statement seen) 2 nd A1 (dep on 1 st A1 but indep of hyp’s) for a suitable conclusion in context that suggests <u>support</u> for (Kamil’s) <u>claim</u> or states that there is evidence that <u>proportion</u> <u>/probability/chance</u> of packets containing a <u>prize</u> is less than $\frac{1}{7}$		
Normal	Do not award 2 nd A1 for contradictory statements e.g. “not significant” so “supports claim” Sight of $N\left(\frac{110}{7}, \frac{660}{49}\right)$ or awrt 13.5 or probability of 0.045(20.) or 0.033(66..) scores M1		

Qu 3	Scheme	Marks	AO
(a)	$H_0 : p = 0.1$ $H_1 : p \neq 0.1$ [Allow 10% for 0.1] $[X \sim B(40, 0.1)] \Rightarrow P(X = 0) = 0.0148$ [Allow any letter for X] $P(X \dots 9) = 1 - P(X \dots 8) = 1 - 0.9845 = 0.0155$ Critical region is $\underline{\{X = 0\} \cup \{X \dots 9\}}$ (o.e.)	B1 M1 A1 A1	2.5 3.3 1.1b 1.1b
(b)	[“0.0148” + “0.0155”] = 0.0303	B1ft (4)	1.1b
(c)	[Provided 7 is not in their CR] insufficient evidence to support Freya’s belief	B1 (1)	2.2b
		(6 marks)	
Notes			
Mark (a) and (b) together for sight of the probabilities.			
(a)	B1 for both hypotheses in terms of p or π . Must be attached to H_0 and H_1 M1 for <u>use</u> of the correct model. Implied by sight of at least one probability truncated or rounded to at least 2sf from: 0.0155, 0.0148, 0.0805, 0.9845, 0.9581, 0.9949 Implied by sight of fully correct CR (with no probs) so e.g. $X = 0$, $X > 8$ scores M1A0A0 1 st A1 for at least one correct probability (to at least 3sf) with its probability statement i.e. for $P(X = 0) = \text{awrt } 0.0148$ <u>or</u> $P(X \dots 9) = \text{awrt } 0.0155$ 2 nd A1 (dep on M1 and 1st A1 but not on B1) for both correct probs (to at least 3 sf) <u>and</u> the correct critical region Do not need set notation. Allow $X < 1$ and $X > 8$ <u>or</u> words e.g. “0 or greater than 8” etc Allow “,” <u>or</u> “and” <u>or</u> “or” <u>or</u> “ \cap ” between $X \dots 0$ and $X \dots 9$ $P(X = 0)$ and $P(X \dots 9)$ is 2 nd A0		
(b)	B1ft for awrt 3.03% <u>or</u> correct sum of their two probabilities (provided each is less than 0.5) Their probabilities must be to at least 2sf and relate to their CR		
To score in (c) they must have a CR of the form $(X = 0 \text{ or } X < a)$ and $X > b$, where b is ...7 May be implied by $P(X < a)$ and $P(X > b)$ i.e. 2nd A0 in (a) but correct form. Need $b > a$			
(c)	B1 for a suitable comment in context that suggests <u>no support</u> for Freya’s <u>belief/claim</u> or e.g. <u>insufficient</u> evidence of change in <u>proportion/percentage</u> of <u>left-handed</u> adults or e.g. <u>proportion/percentage</u> of <u>left-handed</u> adults is <u>not different</u> from 10% (or ...is 10%) or e.g. <u>10%</u> of adults in the country are <u>left-handed</u> Do not allow contradictory comments e.g. “in CR so no support for Freya’s belief” is B0		
NB	A correct contextual answer in (c) using an acceptance region please send to review.		