A level Mathematics Practice Paper – Hypothesis testing – Mark scheme

Question	Scheme	Marks
1(a)	$H_0 : p = 0.15 \quad H_1 : p \neq 0.15$	B1 B1
	$X \sim B(30, 0.15)$	M1
	$P(X \leq 1) = 0.0480$ or CR: $X = 0$	A1
	$(0.0480 > 0.025)$	
	not a significant result or do not reject H_0 or not in CR	M1
	there is no evidence of a change in the proportion of customers buying an item from the display.	A1ft
		(6)
1(b)	$H_0 : p = 0.2 \quad H_1 : p > 0.2$	B1
	Let S = the number who buy sandwiches, $S \sim B(120, 0.2)$,	
	$S \approx W \sim N\left(24, \sqrt{19.2}^2\right)$	M1 A1
	$P(S \geq 31) = P(W \geq 30.5)$	M1
	$= P\left(Z > \frac{30.5 - 24}{\sqrt{19.2}}\right)$ or $\frac{x - 0.5 - 24}{\sqrt{19.2}} = 1.2816$	M1
	$[= P(Z > 1.48..)]$	
	$= 1 - 0.9306$	M1
	$= 0.0694$ $\quad x = 30.1$	A1
	< 0.10 so a significant result, there is evidence that more customers are purchasing sandwiches or the shopkeepers claim is correct.	B1ft
		(8)
		(14 marks)

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Question	Scheme	Marks
2(a)	A statement concerning a **<u>population parameter</u>**	B1
	A critical region is the <u>range</u> / <u>set of values / answers</u> **or** a <u>test statistic</u> **or** <u>region/area</u> **or** <u>values</u> (where the test is significant) that would lead to <u>the rejection of H0 / acceptance of H_1</u>	B1 B1
		(3)
2(b)	$H_0 : p = 0.45$ $H_1 : p < 0.45$ (or $p \neq 0.45$)	
	$X \sim B(20, 0.45)$	M1
	$P(X \leq 5) = 0.0553$ CR $X \leq 4$	A1
	Accept H_0. Not significant. 5 does not lie in the Critical region.	M1d
	There is no evidence that the proportion who voted for <u>Mrs George</u> is not 45% or there is evidence to support <u>Mrs George's</u> claim	A1cso
		(4)
2(c)	B(8, 0.45): P(0) = 0.0084	M1
	B(7, 0.45): P(0) = 0.0152	A1
	Hence smallest value of n is **8**	B1
		(3)
	Alternative	
	$(0.55)^n < 0.01$	M1
	$n\log 0.55 < \log 0.01$	
	$n > 7.7\ldots$	A1
	Hence smallest value of n is **8**	B1cso
		(10 marks)

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Question	Scheme	Marks
3(a)	n is large and p close to 0.5	B1B1
		(2)
3(b)	There would be no pea seeds left	B1
		(1)
3(c)	H_0: $p = 0.55$ H_1 : $p \neq 0.55$	B1
		(1)
	X~N(121, 54.45)	B1
	$P(X \geq 134.5) = P\left(Z \geq \frac{134.5-121}{\sqrt{54.45}}\right)$ or $\pm\frac{x-0.5-121}{\sqrt{54.45}} = 1.96$	M1M1A1
	$= P(Z \geq 1.8295..)$	
	$= 1 - 0.9664$	
	$= 0.0336/0.0337$ $x = 135.96$	A1
	Accept H_0 not in CR, not significant	M1
	The **company's claim** is justified **or** **55**% of its pea **seeds germinate**	A1cso
		(7)
	Alternative	
	X~N(99, 54.45)	B1
	$P(X \leq 85) = P\left(Z \leq \frac{85.5-99}{\sqrt{54.45}}\right)$ or $\pm\frac{x+0.5-99}{\sqrt{54.45}} = 1.96$	M1 M1 A1
	$= P(Z \geq 1.8295..)$	
	$= 1 - 0.9664$	
	$= 0.0336/0.0337$ $x = 107.5$	
	Accept H_0 not in CR, not significant	M1
	The **company's claim** is justified **or** **55**% of its pea **seeds germinate**	A1cso
		(11 marks)

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Question	Scheme	Marks
4	$X \sim \mathrm{N}(40, 3^2)$ $\quad \overline{X} \sim \mathrm{N}\left(40, \frac{9}{n}\right)$ (Condone $Y \sim \mathrm{N}(40, \frac{9}{n})$	B1
	$\mathrm{P}(\overline{X} > 42) = \mathrm{P}\left(Z > \frac{42-40}{\sqrt{\frac{9}{n}}}\right)$	M1
	$\frac{42-40}{\sqrt{\frac{9}{n}}} \geq 1.6449$	B1 dM1
	$n \geq 6.087$	
	$n = 7$	A1
		(5 marks)

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Question	Scheme	Marks
5(a)	$z = \pm\ 3.2905$	B1
	$\sigma = \frac{30}{3.2905}$	M1
	$\sigma = 9.117$ **	A1cso
		(3)
5(b)	$H_0: \ \mu = 1000$ $H_1: \ \mu < 1000$	B1
	mean weight = 999.54	B1
	$z = \frac{\bar{x}-\mu}{\frac{\sigma}{\sqrt{n}}} = \frac{(999.54-1000)}{\frac{9.117}{\sqrt{10}}} = -0.160$ or $\frac{c-1000}{\sqrt{83.12/10}} = -2.3263 \therefore$ CR $c < 993.29$	M1A1
	1% critical value = $-\ 2.3263$	B1
	$-\ 2.3263 < -0.160$	
	Accept H_0 / not in critical region	dM1
	There is no evidence that that the machine is delivering packets of mean weight less than 1 kg	A1ft
		(7)
		(10 marks)

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	Source paper	Question number	New spec references	Question description	New AOs
1	S2 2011	6	A 4.1, 4.2, 5.1, 5.2, 5.3	Binomial distribution, Normal distribution	1.1b, 2.2b, 2.5, 3.3, 3.5a
2	S2 Jan 2013	6	A 5.1, 5.2	Hypothesis testing, Tests on binomial	1.1b, 1.2, 2.5, 3.3, 3.5a
3	S2 2014	5	A 4.1, 4.2, 5.1, 5.3	Continuous distributions, Hypothesis tests	1.1b, 1.2, 2.2b, 2.4, 2.5, 3.3, 3.4
4	S3 2013R	2	A 5.3	Tests on normal mean	1.1b, 2.1, 3.1b, 3.4
5	S3 2014	7	A 5.3	Tests on normal mean	1.1b, 2.1, 2.2b, 2.5, 3.1b, 3.4