Hypothesis Testing 3 MS

Q1.

7	(i)	Assume sd unchanged or 4500	B1	
		H_0: Pop mean = 34600 H_1: Pop mean > 34600	B1	Both. Allow just μ, but not just "mean"
		$\frac{35400-34600}{\frac{4500}{\sqrt{90}}}$	M1	Allow without $\sqrt{90}$
		= 1.687/1.686 (1.69)	A1	
		cf 1.645 < 1.686	M1	Valid comparison (or 0.0458/0.0459 <0.05 or 35380 < 35400 or 34600 < 34620)
		Evidence that mean wkly profit has increased	A1 f 6	If H_1: ≠, and 1.96 used, max B1B0M1A1M1A1f No contradictions
	(ii)	Distr'n of X unknown.	B1*	Allow not Normal
		Yes	B1* dep 2	
	(iii)	0.05 or 5%	B1 1	
	(iv)	$\frac{a-34600}{\frac{4500}{\sqrt{90}}} = 1.645$	M1	Attempt to find cv must see (+) 1.645 allow without $\sqrt{90}$. If found in (i) award when used
		$a = 35380$	A1	
		$\frac{35380-36500}{\frac{4500}{\sqrt{90}}}$ (= – 2.361)	M1	
		1 – Φ('2.361') = 0.0091	M1 A1 6	Standardising with their " CV " must use $\sqrt{90}$ Correct tail
			[Total: 14]	

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Q2.

5	**(i)**	E (X)= 3.5 $(1^2+2^2+3^2+4^2+5^2+6^2) \div 6 -$ "3.5"^{2} $(=\frac{35}{12}$ **AG)**	**B1** **B1**	**2**	21/6 oe, must see correct expression and no incorrect working
	(ii)	Attempt P $(X < 3)$ or $1 - P(X \geq 3)$ N $(3.5, \frac{35}{12}/50)$ $\frac{3-"3.5"}{\sqrt{\frac{35}{12}/50}}$ $(= -2.070)$ Φ ("–2.070") = 1 – Φ("2.070") = 0.0192 as final answer	**M1** **M1** **M1** **M1** **A1**	**5**	seen or implied seen or implied or $\frac{2.99-"3.5"}{\sqrt{\frac{35}{12}/50}}$ $(= -2.111)$ Φ ('–2.111') = 1 – Φ ('2.111') = 0.0174 or 0.0173 Consistent area As final answer or valid total method Allow with incorrect cc (e.g. 2.5) OR no √.Must have ÷50
	(iii)	Die is biased (towards lower numbers) Mean of 50 throws ≥ 3 (Allow > 3) or Equal nos of high and low scores or More high scores	**B1 indep** **B1 indep**	**2**	Comment implying die is biased Comment implying results of exp't do not indicate bias (or indicate bias towards higher numbers) Both must be in context
Total				**[9]**	

Q3.

6	**(i)**	H_0: Rate = 0.9 H_1: Rate < 0.9 1 – P(17, 18, 19, 20) $1 - ({}^{20}C_{17} \times 0.1^3 \times 0.9^{17} + {}^{20}C_{18} \times 0.1^2 \times 0.9^{18} + 20 \times 0.1 \times 0.9^{19} + 0.9^{20})$ = 0.133 (3 sf)	 B1 M1 M1 A1	[4]	p = 0.9 p < 0.9 Use of B(20,0.1) Allow 1–P(18,19,20) or 1–P(16,17,18,19,20)
	(ii)	Type II H_0 will not be rejected	B1 B1	[2]	or Stephan will conclude standard not fallen No contradictions
			[Total: 6]		

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Q4.

7 (i)	2nd More representative of all appointments or Lengths may vary during the day or 1st does not include later appts so not representative	B1 B1 [2]	Any implication that times or conditions vary throughout day, e.g. doctors get tired	
(ii)	0.01 o.e. Concluding that times spent are too long when they are not.	B1 B1 [2]	Concluding that the mean time spent is more than 10 mins when it is not. Must be in context.	
(iii)	H_0: Pop mean appt time (or μ) = 10 H_1: Pop mean appt time (or μ) > 10 $\frac{\frac{147}{12}-10}{\frac{3.4}{\sqrt{12}}}$ (±) = (±)2.292 or (0.0109 if area comparison done) "2.292" < 2.326 o.e. (No evidence to reject H_0.) No reason to believe appts are too long	B1 M1 A1 M1 A1√ [5]	Both correct. Allow μ, but not just "mean" Allow incorrect $\frac{147}{12}$ Must have $\sqrt{12}$ (accept totals method) For valid comparison Comp "2.292" with 2.326 Or 0.0109 with 0.01 Or 147/12 with 12.28 Dep 2.326, ft their "2.292" No contradictions	$10 + 2.326 \times \frac{3.4}{\sqrt{12}}$ M1 = 12.28 A1 $\frac{147}{12} < 12.28$ M1
(iv)	Normal population	B1 [1]	Must have "population" or equiv	

Hypothesis Testing 3 MS

Q5.

6 **(i)**	H_0: $p = 0.2$ H_1: $p < 0.2$	B1		(Allow π)
	P(0 or 1 5s in 25 | H_0)	M1		$0.8^{25} + 25 \times 0.8^{24} \times 0.2$ Use of B(25,1/5) and P(0) or P(1) or both – may be implied by "0.0274"
	= 0.0274 (3 s.f.)	A1		
	Comp with 0.025	M1		Valid comparison
	No evidence (at 2.5% level) to support claim	A1	[5]	No contradictions **SR** Use of Normal N(5,4) leading to $z = 1.75$ or 0.0401 **B1*** H_0 $\mu = 5$ H_1 $\mu < 5$ B1. Comparison $1.75 < 1.96$ or $0.0401 > 0.025$ **B1* dep**
(ii)	Normal	B1		
	$\mu = 200$, $\sigma^2 = 160$ or $\sigma = \sqrt{160}$	B1	[2]	
(iii)	Concluding that the machine produces the right proportion of 5s, although it doesn't.	B1	[1]	Not concluding that the machine produces too few 5s although it does. Must be in context o.e. No contradictions

Q6.

1 **(i)**	"Different" being investigated	**B1**	**[1]**	Oe ("changed", "not equal to")
(ii)	H_0: Pop mean (or μ) in region same as elsewhere			Must be "pop mean", not just "mean" Can be awarded in (i)
	H_1: Pop mean (or μ) in region diff from elsewhere	**B1**		oe
	$1.91 < 2.054$ (or 2.055) or $-1.91 > -2.054$	**M1**		or $P(z > 1.91) = 0.0281 > 0.02$ or $0.0562 > 0.04$ or $0.972 < 0.98$ Accept 2.05 if nothing better seen.
	No evidence that mean is different	**A1**	**[3]**	inequality sign incorrect M1A0 no contradictions "accept H_0" provided H_0 reasonably well defined
Total			**[4]**	

Hypothesis Testing 3 MS

Q7.

6 (i)	$\lambda = 4.65$ $e^{-4.65} \times \frac{4.65^4}{4!}$ $= 0.186$ (3 sf)	B1 M1 A1 3	 Poisson P($X = 4$) with any λ
(ii)	$\lambda = 3.875$ $= e^{-3.875}\left(1 + 3.875 + \frac{3.875^2}{2!}\right) = 0.257$ (3 sf)	B1 M1 A1 3	 P($X = 0, 1, 2$) Attempted, any λ As final answer
(iii)	$\lambda = 1.5$ $1 - e^{-1.5}\left(1 + 1.5 + \frac{1.5^2}{2!}\right)$ $= 0.191$ (3 sf)	B1 M1 A1 3	 1 – P($X = 0, 1, 2$) Attempted, any λ As final answer
(iv)	He will reject H_0.	B1 1	
		Total: 10	