Hypothesis Testing 1 MS

Q1.

3 **(i)** $z = \dfrac{2.55 - 2.62}{0.3/\sqrt{45}} = -1.565$	M1	Standardising no cc
	M1	Dividing 0.3 by $\sqrt{45}$ as denominator
$P(z > -1.565) = 0.941$	A1	Correct answer (Accept equivalent method using totals)
	[3]	
(ii) rejection region is $m < a_1$ and $m > a_2$		
where $\dfrac{a_1 - 2.62}{0.3/\sqrt{30}} = -1.645$	B1	± 1.645 seen
and $\dfrac{a_2 - 2.62}{0.3/\sqrt{30}} = 1.645$	M1	one correct unsimplified equation of correct form
	M1	second unsimplified equation of correct form (or clear use of 1-tail test and ± 1.282 used)
$m < 2.53$ and $m > 2.71$	A1	correct answer
	[4]	

Q2.

7 **(i)** Type I error is made when we say the number of white blood cells has decreased when it hasn't.	B1	Correct and relating to question
$P(0) = e^{-5.2} = 0.005516$	M1	Evaluating at least 2 of $P(X = 0, 1, 2)$
$P(1) = e^{-5.2}(5.2) = 0.02868$ $\Sigma < 0.10$	M1*	Comparing their Σ 3 probs with 10% (must be Σ probs)
$P(2) = e^{-5.2}(5.2^2/2) = 0.07458$ $\Sigma > 0.10$		
P(Type I error) = 0.0342	A1dep	Correct answer, dep on previous M
	[4]	
(ii) H_0: $\lambda = 5.2$		
H_1: $\lambda < 5.2$	B1	Both hypotheses correct
$P(0+1+2) = 0.1087 > 10\%$		
2 not in C Region.	M1	Stating 2 is not in the critical region from above, or evaluating P(0, 1, 2) and comparing with 10% again
Accept H_0. Not enough evidence to say the number of blood cells has decreased.	A1	Correct conclusion no contradictions
	[3]	
(iii) P(Type II error) = 1 – P(0, 1)	B1	Identifying correct area
$= 1 - e^{-4.1}(1 + 4.1)$	M1	(indep) Some form of (Poisson) expression with mean 4.1
$= 0.915$	A1	Correct answer
	[3]	

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Q3.

5	**(i)**	E(F) = 28 + 1/2 × 52 = 54 Var(F) = $5.6^2 + 1/4 \times 12.4^2$ = 69.8	B1 M1 A1 [3]	 √69.8 or 8.35: M1A0
	(ii)	H_0: Grinford mean = 54; H_1; Grinford mean < 54	B1ft	Allow "μ", otherwise undefined mean: B0 ft their 54
		$\frac{49-54}{\sqrt{\frac{69.8}{10}}}$	M1	Standardising must have √10
		= –1.89(3) or –1,89(2) allow + Comp with –1.645 (or 1.893 with 1.645)	A1 M1	 Comp P(z < –1.893) with 0.05 Allow comparison with 1.96 for consistent 2-tail test
		Evidence that Grinford mean lower	A1ft [5]	Allow "Accept Grinford mean lower" No contradictions OR Alt methods (x – 54)/(√(69.8/10)) = 1.645 giving x = 49.65 compare with 49 scores M1A1M1A1ft. oe. No mixed methods.

Q4.

7	**(i)**	Var($\bar{X}$) = $\frac{121}{200}$ or SD of $\bar{X}$ = $\frac{11}{\sqrt{200}}$		
		$(\pm)\frac{354-352}{\frac{11}{\sqrt{200}}}$ (= ± 2.571)	M1 A1	Or with cc attempted. Allow no √ Must include 200 or √ 200 2.57(1) or correct expression
		1 – Φ("2.571") (= 1 – 0.9949) = 0.0051	M1 A1 [4]	
	(ii)	(No) n is large, $\bar{X}$ (appr) norm distr or CLT applies	 B1 B1 [2]	"No" must be seen or implied, but gains no marks by itself $n \geq 30$ (SR Both statements correct, but wrong or no conclusion scores B1)
	(iii)	H_0: Pop mean = 352 H_1: Pop mean ≠ 352	 B1	 Allow 'μ' but not just 'mean'
		$\pm\frac{356-352}{\frac{11}{\sqrt{50}}}$ ± (= 2.57(1))	M1 A1	Must have √ 50 Correct statement or 2.57(1)
		Comp with z = ±1.96 (signs consistent) Evidence that pop mean has changed	B1√ [4]	Correct comparison, and correct conclusion, follow through one tail test
		[Total: 10]		

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Q5.

2	H_0: P(correct) = $^1/_5$ H_1: P(correct) > $^1/_5$ B(100, $^1/_5$) ≈ N(20, 16)	B1	Accept p Accept H_o: $\mu = 20$ H_1: $\mu > 20$
	$\frac{26.5 - 20}{4} = 1.625$	M1 A1 A1	Allow wrong or no cc or denom = 16 For ± 1.625
	comp $z = 1.645$	M1	Valid comparison of z or areas (0.0521 > 0.05)
	Claim not justified	A1ft [5]	In context. No contradictions. Ft their z.

Q6.

1 (i)	H_0: Pop mean = 3 H_1: Pop mean > 3	B1 [1]	Allow or μ or λ, but not just 'mean'
(ii)	0.0683 > 0.05 No evidence that pop mean increased	M1 A1ft [2]	For inequality stated or clearly shown on dig. Allow 'No increase in mean'
		[Total: 3]	

Q7.

5 (i)	P(> 9 Heads | unbiased) = $^{12}C_{10} \times 0.5^{10} \times 0.5^2 + 12 \times 0.5^{11} \times 0.5 + 0.5^{12}$ = 0.0193 Level is 1.93% or 1.9%	M1 M1 A1 3	Allow Bin P(X = 9, 10, 11, 12) correct or 1 – P(X = (9),10,11,12)) any p/q Allow Bin P (X = 9, 10, 11, 12) correct p/q Allow 2% if correct working seen
(ii)	B(100, 0.5) ≈ N(50, 25) $\frac{x-0.5-'50'}{\sqrt{'25'}} = z$ $z = 1.645$ $x = 58.7$ Rejection region is › 59	B1 M1 B1 A1 A1ft 5	Or proportion method N(0.5,0.0025) Allow with wrong or no cc or no √ (cc for proportion method 0.5/100) + only (consistent with their standardisation) or > 58 (region and integer required)
		[Total 8]	