1	Est(μ) = 1.8775 or 1.88 (3 sf)	B1		Accept 751/400 (not 150.2/80)
	Est(σ^2) = $\frac{80}{79}\left(\frac{820.24}{80} - \text{"}1.8775\text{"}^2\right)$	M1		Correct subt'n in correct formula 1/79 (820.24 – 150.2^2/80)
	= 6.81316 or 6.81 (3 sf)	A1		
	z = 1.96	B1		Seen
	"1.8775" ± z × $\sqrt{\frac{\text{"}6.81316\text{"}}{80}}$	M1		
	= 1.31 to 2.45 (3 sf)	A1	6	Must be an interval. NB use of biased var can still score A1.
Total			**[6]**	
2 (i)	Assume sd unchanged or sd = 10.4	B1		Oe e.g. var unchanged
	H_0: Pop mean speed (or μ) = 62.3 H_1: Pop mean speed (or μ) < 62.3	B1		Both. Not just "Mean . . "
	$\frac{59.9-62.3}{\frac{10.4}{\sqrt{75}}}$	M1		Accept sd/var mixes, but must have √ 75
	= – 1.999 or – 2.00 (allow + or –)	A1		Correct z value (or correct critical value)
	Compare – 2.054 or –2.055	M1		Valid comparison of z`s/areas/critical values
	No evidence that mean speed decreased	A1 ft	6	No contradictions. Do not ft 2-tail test.
(ii)	Pop distribution unknown	B1		
	Yes	B1	2	
Total			**[8]**	
3 (i)	$\int_0^{10} \frac{1}{2500}\left(100t^3 - t^5\right)dt$	M1		Attempt integ t^2f(t)
	(= $\frac{1}{2500}\left[25t^4 - \frac{t^6}{6}\right]_0^{10} = \frac{100}{3}$)			
	"$\frac{100}{3}$" – $(\frac{16}{3})^2$	M1		For E (T^2) – (E (T))^2
	= $\frac{44}{9}$ or 4.89 (3 sf)	A1	3	
(ii)	$\int_n^{10} \frac{1}{2500}\left(100t - t^3\right)dt$	M1		Attempt integ f(t), ignore limits
	$\frac{1}{2500}\left[50t^2 - \frac{t_4}{4}\right] = 0.1$	M1		Attempt integ f(t), limits n to 10 or 0 to n Equated to 0.1 or 0.9. Not need to be matched
	$\frac{1}{2500}\left[2500 - \left(50n^2 - \frac{n^4}{4}\right)\right] = 0.1$	M1		0.1/0.9 matched to correct limits and used
	($n^4 - 200n^2 + 9000 = 0$)	M1		Correct method of solution of a QE in n^2
	(n^2 = 68.3772, n = 8.27) n = 8	A1	5	Must be single ans only
Total			**[8]**	

4 (i) (a)	$e^{-2.1} \times \frac{2.1^3}{3!}$ alone = 0.189	M1 A1	 2	Allow any λ. Allow sum of 3 or 4 rel products, e.g. P (3, 0)
(b)	$e^{-1.2} \times \frac{1.2^3}{3!} \times e^{-0.9}$ $+ e^{-1.2} \times \frac{1.2^2}{2!} \times e^{-0.9} \times 0.9$ = 0.115	M1 M1 A1	 3	P (Fem = 3) × P (Opp = 0) or P (Fem = 2) × P (Opp = 1) P (3, 0) + P (2, 1) As final answer
(ii)	N (30, 30) $\frac{34.5-30}{\sqrt{30}}$ (= 0.8216) 1 – Φ(“0.822”) = 0.206 (3sf)	B1 M1 M1 A1	 4	seen or implied standardising with their N (λ, λ) Allow with no or incorrect cc or no √ Area consistent with their working
Total				
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) $\frac{3-\text{"3.5"}}{\sqrt{\frac{35}{12}/50}}$ (= –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 $\frac{2.99-\text{"3.5"}}{\sqrt{\frac{35}{12}/50}}$ (= –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]	

6 (i)	N(5100, 5×45^2) or N(5100, 10125)	B1		seen or implied
	$\frac{5200-"5100"}{\sqrt{"10125"}}$ (= 0.994)	M1		standardising with their new mean and new var
	Φ ("0.994")	M1		area consistent with their working with normal
	= 0.840 (3 sf)	A1	4	
(ii)	Use of $E - 3L$ or similar	M1		
	E $(E - 3L) = -260$	B1		2800 – 3 x 1020
	Var $(E - 3L) = 52^2 + 9 \times 45^2$ or 20929	B1		
	$\frac{0-("-260")}{\sqrt{"20929"}}$ (= 1.797)	M1		with a pos var with 45^2 and 52^2 combined
	$1 - \Phi$ ("1.797")	M1		consistent area, must clearly be φ
	= 0.0361 (3 sf) or 0.0362	A1	6	P ($3L - E < 0$): similar scheme SR: use of 3E – L, M1, 7380 B1, 26361 B1 stand 0 with these values M1, M0A0 max 4/6
Total			[10]	