1	$e^{-3.5}(1 + 3.5 + \frac{3.5^2}{2!})$ = 0.321 (3 sf)	**M2** **A1**	[3]	Allow M1 if extra term $e^{-3.5} \times \frac{3.5^3}{3!}$ or " 1 - . " or omit P(0)
2 (i)	59	**B1**	[1]	
(ii)	Any x such that $0.687 \leqslant x \leqslant 0.693$ (3 sf)	**B1**	[1]	or 0.69 or " ... 0.686.. < 0.693 rec "
(iii)	Possible repeats	**B1**	[1]	
3	N(178, …) Var = $3.2^2 + 4.1^2 + 3.8^2$ or 41.49 $\frac{175-'178'}{\sqrt{'41.49'} \div \sqrt{15}}$ (= '–1.804') Φ('–1.804') = 1 – Φ ('1.804') = 0.0356 (3 sf)	**B1** **B1** **M1** **M1** **A1**	 [5]	stated or implied or sd = 6.44 stated or implied need √15 but allow var / sd mix for "41.49" allow cc for method marks independent M1 for area / prob consistent with working
4	$\frac{11.8-11}{1.6 \div \sqrt{n}} = 1.645$ $\frac{11.8-11}{1.6 \div \sqrt{n}} = 1.96$ $n = 10.8$ (allow 11) $n = 15.4$ (allow 15) Possible values are 11, 12, 13, 14, 15	**M1** **B1** **B1** **A1** **A1**	 [5]	M1 for $\frac{11.8-11}{1.6 \div \sqrt{n}}$ = any z allow var / sd mix for 1.6 but need $\sqrt{n}$ B1 for each correct z for both not for just $11 \leqslant n \leqslant 15$ oe

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5 (i)	H_0: P(free gift) = 0.3 or $p = 0.3$ H_1: P(free gift) < 0.3 or $p < 0.3$	**B1**	[1]	
(ii)	P($X \leqslant 2$) = $0.7^{20} + 20 \times 0.7^{19} \times 0.3 + {}^{20}C_2 \times 0.7^{18} \times 0.3^2$ = 0.03548 or 0.0355	**M1*** **A1**		P($X \leqslant 2$) attempted
	P($X \leqslant 3$) = '0.03548' + ${}^{20}C_3 \times 0.7^{17} \times 0.3^3$ (= 0.107)	**M1***		P($X \leqslant 3$) attempted
	One comparison with 0.05 seen	**M1***		or implied by fully correct methods for P($X \leqslant 2$) and P($X \leqslant 3$)
	P(Type I error) = 0.0355 (3 sf)	**DA1** √	[5]	dep on all 3 Ms
(iii)	P($X \leqslant 3$) = '0.107' '0.107' > 0.05 **or** cv = 2 and compare 3 >2	**M1**		Compare their P($X \leqslant 3$) with 0.05
	No evidence to reject claim oe	**A1** √	[2]	No evidence that 30% is not correct oe ft their 0.107
6 (i)	est(μ) = 3.4 est(σ^2)= $\frac{100}{99}(\frac{1356}{100} - '3.4'^2)$ = 2.02(0202)	**B1** **M1** **A1**		1 / 99 (1356 – $340^2/100$) or 200/99
	z = 1.96	**B1**		
	$3.4 \pm z \times \sqrt{\frac{'2.020202'}{100}}$ = 3.12 to 3.68 (3 sf)	**M1** **A1**	[6]	correct working only allow from unbiased or biased variance
(ii)	Mean should be 3	**B1***		stated or implied
	CI does not include 3 Machine probably not working properly	**DB1**√	[2]	√ their CI or evidence that….
7 (i)	$1 - e^{-1}$ (1 + 1) (= 0.26424) $1 - e^{-1.5}(1 + 1.5 + \frac{1.5^2}{2!})$ (= 0.19115)	**B1** **B1**		B1 for either λ correct. B1 for either correct expression with correct λ
	'0.26424' × '0.19115'	**M1**		product of their values for $\leqslant 2$ and $\leqslant 3$ from Poisson, need correct form " 1 - .. " , but allow incorrect λ values and end errors
	= 0.0505 (3 sf)	**A1**	[4]	accept 0.0504

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(ii)	$\lambda = 30$ N(30, 30)	**B1** **B1**√		seen or implied, need N(λ,λ)
	$\frac{35.5-30}{\sqrt{30}}$ (= 1.004)	**M1**		allow with wrong or no cc or no √
	Φ ('1.004')	**M1**		consistent with their working
	= 0.842 (3 sf)	**A1**	[5]	
8 (i)	σ_X, σ_Z, σ_Y, σ_W **or** X, Z, Y, W	**B2**	[2]	B1 if two adjacent sds interchanged, ie σ_Z, σ_X, σ_Y, σ_W **or** σ_X, σ_Y, σ_Z, σ_W **or** σ_X, σ_Z, σ_W, σ_Y B1 for correct order reversed
(ii) (a)	Mean = 0 stated or found or "– 0" seen	**B1**		
	$\frac{1}{18}\int_{-3}^{3} x^4 \mathrm{d}x - 0$ $= \frac{1}{18}\left[\frac{x^5}{5}\right]_{-3}^{3}$ $= \frac{1}{18}\left[\frac{3^5}{5}+\frac{3^5}{5}\right]$ oe = 5.4	**M1**		Attempt integral ^{2} f(x). Ignore limits Allow without "– 0"
	sd = √5.4 or $\sqrt{\frac{1}{18}\left[\frac{3^5}{5}+\frac{3^5}{5}\right]}$ or 2.324 sd = 2.32 (3 sf) AG	**A1**	[3]	Must see $\sqrt{\text{correct expression or 5.4}}$ or 2.324 or better
(b)	$\frac{1}{18}\int_{'2.324'}^{3} x^2 \mathrm{d}x$	**M1**		Attempt to integrate f(x), ignore limits
	$\frac{1}{18}\left[\frac{x^3}{3}\right]_{'2.324'}^{3} = \frac{1}{18}\left[\frac{3^3}{3}-\frac{'2.324'^3}{3}\right]$	**A1**		Sub correct limits into correct integral
	= 0.268 (3 sf)	**A1**	[3]	Allow 0.269
(c)	0	**B1**	[1]	

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