1	$0.605 \pm z \times \sqrt{\frac{0.605\times(1-0.605)}{1000}}$ $z = 1.645$ seen [0.580, 0.630]	M1 B1 A1 [3]	 Allow [0.58, 0.63]. Allow any brackets
2	**(i)** $e^{-\frac{10}{3}} \times \frac{(\frac{10}{3})^4}{4!}$ = 0.184 or 0.183	M1 A1 [2]	Allow incorrect λ
	(ii) $\lambda = 5$ $e^{-5}(1 + 5 + \frac{5^2}{2})$ = 0.125 (3 sfs)	B1 M1 A1 [3]	 Allow incorrect λ. Allow one end error OR Combination method scores B1, identifying all 6 possible combinations M1, multiply each combination and add (must use at least 5 combinations) A1
3	**(i)** B(40 000, 0.0001)	B1 [1]	
	(ii) Po(4) $n = 40\,000 > 50$, $np = 4 < 5$	B1*B1*dep B1 [3]	B1 for Po. B1 for 4 Accept 40000 large and 0.0001 small
	(iii) $1 - (P(X \le 3)$ or $e^{-4}(1 + 4 + \frac{4^2}{2} + \frac{4^3}{3!}))$ $1 - e^{-4}(1 + 4 + \frac{4^2}{2} + \frac{4^3}{3!})$ = 0.567 or 0.566	M1 M1 A1 [3]	Allow one end error (any λ) Expression of correct form (any λ), no end errors. (OR Use of normal scores M1, standardising M1, standardising with correct cc A1ft, **(ii)** 0.599. Award A mark only if normal given in **(ii)**) (OR Binomial M1 expression of correct form allow end error, M1 correct form no end error, A1ft 0.567 or 0.566. Award A mark only if Bin given in **(ii)**) NB Part **(iii)** must be Poisson or ft from **(ii)** for A mark to be awarded. SR If no answer given in **(ii)** allow BOD for A marks.

4	(i)	$0.5(0.5 + 0.75)\times0.5$ or $\int_1^{1.5} \frac{x}{2}\,dx$ $= {}^5/_{16}$ or 0.3125 or 0.313	M1 A1 [2]	Attempt find correct area eg 1 squ + $^1/_4$ squ or integral with correct limits any f(x)
	(ii)	$^1/_2\, m \times {}^m/_2$ or $\int_0^m \frac{x}{2}\,dx$ $= {}^1/_2$ $m = \sqrt{2}$ or 1.41	M1 M1 A1 [3]	Attempt area from 0 to m (or m to 2) their f(x) Expression for area = $^1/_2$. Ignore limits
	(iii)	$\int_0^2 \frac{x^2}{2}\,dx$ $= {}^4/_3$ oe	M1 A1 [2]	Attempt $\int x\mathrm{f}(x)\,dx$. Ignore limits
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]	$\sqrt{69.8}$ or 8.35: M1A0
	(ii)	H_0: Grinford mean = 54; H_1; Grinford mean < 54 $\dfrac{49-54}{\sqrt{\frac{69.8}{10}}}$ = –1.89(3) or –1,89(2) allow + Comp with –1.645 (or 1.893 with 1.645) Evidence that Grinford mean lower	B1ft M1 A1 M1 A1ft [5]	Allow "μ", otherwise undefined mean: B0 ft their 54 Standardising must have $\sqrt{10}$ Comp P(z < –1.893) with 0.05 Allow comparison with 1.96 for consistent 2-tail test Allow "Accept Grinford mean lower" No contradictions OR Alt methods $(x - 54)/(\sqrt{(69.8/10)}) = 1.645$ giving $x = 49.65$ compare with 49 scores M1A1M1A1ft. oe. No mixed methods.

6	(i)	H_o: $P(6) = {}^1/_6$ H_1: $P(6) > {}^1/_6$	B1		Allow "p"
		$1 - ((^5/_6)^{10} + 10(^1/_6)(^5/_6)^9 + {}^{10}C_2(^1/_6)^2(^5/_6)^8)$	M1		Allow 1 term omitted or extra or incorrect
		= 0.225 (3 sfs) 0.225 > 0.1	A1 M1		Allow correct comparison with 0.9, and recovery of previous then M1A1 possible.
		No evidence that die biased	A1ft	[5]	Allow Accept die not biased. In context. SR Calc just P(3)max score B1M0A0M1A0
	(ii)	P(4 or more sixes)	M1		Idea of 1 – Σ of terms oe compared with 0.1
		$= 1 - ((^5/_6)^{10} + 10(^1/_6)(^5/_6)^9 + {}^{10}C_2(^1/_6)^2(^5/_6)^8 + {}^{10}C_3(^1/_6)^3(^5/_6)^7)$	M1		1 – Σ of appropriate no.terms oe compared with 0.1
		= 0.0697 or 0.0698	A1	[3]	
	(iii)	Concluding die is fair when die is biased	B1	[1]	Must be in context
7 (a)	(i)	Pop too large Not all pop accessible	B1	[1]	Time consuming Or similar
	(ii)	Testing involves destruction	B1	[1]	Or similar
(b)	(i)	$^{9850}/_{500} = (19.7)$ $^{500}/_{499}(^{194125}/_{500} - (^{9850}/_{500})^2)$ = 0.160(32) (3 sfs) or 80/499	B1 M1 A1	[3]	Allow with √. Method must be seen or clearly implied.
	(ii)	$\frac{19.73-19.7}{\sqrt{\frac{"0.160"}{60}}}$	M1		For standardising
		= 0.580 or 0.581 1 – Φ("0.580") (= 1 – 0.7191) = 0.281	A1ft M1 A1	[4]	ft their mean and var in **(b)(i)** Correct tail
	(iii)	"Yes" must be seen or implied to gain mks *X* not nec'y normal Sample large	 B1 B1	[2]	or $\overline{X}$ is approx N (SR Both reasons correct, but wrong or no conclusion scores SR B1)