1	bars are not touching oe	B1		Sensible reason involving not touching, no gaps, class boundaries, group data not continuous (may be the negative)
	Area not rep by frequency, not used fd, not labelled fd	B1	**2**	Must be frequency density oe. Wrong height not sufficient. (Best 2 reasons awarded)
2	$P(13.6 < X < 14.8) = P\left(\frac{13.6-14}{0.52} < z < \frac{14.8-14}{0.52}\right)$	M1		Standardising 1 expression, no cc, no sq rt, no sq, ±, mean on num.
	$= P(-0.7692 < z < 1.538)$ $= \Phi(1.538) - [1 - \Phi(0.7692)]$ $= 0.9380 - [1 - 0.7791]$ $= 0.7171$	M1 A1		$\Phi 1 + \Phi 2 - 1$ (indep) oe ($\Phi 2 - \Phi 1$ if cc used) Correct probability rounding to 0.72 here
	$P(8) = (0.7171)^8(0.2829)^2{}_{10}C_8$ $= 0.252$	M1 A1	**5**	Binomial expression $10C8\ p^8q^2$, $\Sigma p + q = 1$, any p Correct answer (rounding to 0.252)
3	**(i)** $(p =)0.85$ $P(< 12) = 1 - P(12, 13, 14)$ $= 1 - [(0.85)^{12}(0.15)^2{}_{14}C_{12} + (0.85)^{13}(0.15)_{14}C_{13} + (0.85)^{14}]$ $= 1 - 0.6479$ $= 0.352$	B1 M1 A1	**3**	$(p =)0.85$ oe seen anywhere Summing 2 or 3 consistent bin probs, any $p < 1$, $n = 14$ (or summing 12 or 13 consistent bin probs) Correct answer
	(ii) $(0.85)^n \geqslant 0.1$ $n \leqslant 14.2$ $n = 14$	M1 M1 A1	**3**	Eqn or inequality in 0.85(or 0.15), n, 0.1, n as a power Attempt to solve (can be implied) if n a power Correct answer – must be equals, not approx. MR allowed for 0.01, M1M1A0 max.
4	**(i)** $(220\times20 + 118\times25)/45$ $= 163$	M1 A1	**2**	Mult by 20 and 25 and dividing their sum by 45 Correct answer, 163.3 or 490/3 oe acceptable
	(ii) $\Sigma x_o^2/20 - 220^2 = 32^2$ $\Sigma x_o^2 = 988480$	M1 A1		Subst in correct variance formula Correct Σx_o^2
	$\Sigma x_I^2/25 - 118^2 = 12^2$ $\Sigma x_I^2 = 351700$	A1		correct Σx_I^2
	$\Sigma x_o^2 + \Sigma x_I^2 = 1340180$ New var $= 1340180/45 - (7350/45)^2$ $= 3100 - 3120$	M1 A1	**5**	Subst their combined results in correct var formula Correct answer

5	**(a)**	P($X < q + 82$) = 0.72 $z = 0.583$ $\frac{\pm q}{7.4}$ *or* $\frac{\pm 2q}{7.4} = z$ *or probabilty* (o.e.) $q = 4.31$	M1 M1 A1 **3**	Rounding to ± 0.58 or ± 0.15 seen Standardising, no cc, no sq, no sq rt correct answer
	(b)	$\frac{0.5\mu - \mu}{\sigma} = \frac{\pm 0.5\mu}{\sigma}$ $\frac{0.2\sigma^2}{\sigma} = -0.2\sigma = -0.580$ $\sigma = 2.90$ $\mu = 3.36$	M1 B1 M1 A1 **4**	Standardising attempt some μ/σ allow cc, sq rt, sq Can be implied ± 0.580 seen (accept ±0.58) substituting to eliminate μ or σ , arriving at numerical solution, any *z* value or probability – not dependent both answers correct , accept 2.9
6	**(i)**	$\frac{8!}{3!2!2!}$ = 1680	M1 A1 **2**	8! Divided by at least one of 3!2!2! oe Correct answer
	(ii)	5! = 120	M1 A1 **2**	5! Seen (not added, may be divided/multipled) Correct answer
	(iii)	$\frac{5!4!}{3!2!2!}$ = 120	B1 M1 A1 **3**	5! Or 4! Seen in sum or product in numerator (denominator may by 1) $\frac{k5!4!}{3!2!2!}$ in a numerical expression Correct final answer
	(iv)	GG with AA, AE, EE, RA, RE, RT, TA, TE, = 8 ways GGG with A, E, R, T = 4 ways Total = 12 ways	M1 A1 A1 **3**	Summing 2 options (could be lists) 1 correct option Correct answer

7	**(i)**	P(same) = P(1, 1)+ P(3, 3) + P(5, 5) $= \frac{2}{9}\times\frac{1}{8}+\frac{4}{9}\times\frac{3}{8}+\frac{3}{9}\times\frac{2}{8}$ = 5/18 (0.278) Alt. method: $\frac{2C2+4C2+3C2}{9C2}$ or $\frac{2\times1+3\times4+2\times3}{9C2\times2}$ *oe*	M1 M1 A1 **3**	Summing 3 two-factor options Multiplying terms by one less in the numerator or denominator Correct answer M1 for numerator, M1 for denominator, A1 correct answer
	(ii)	P(5, $\bar{5}$) + P($\bar{5}$, 5) $= \frac{3}{9}\times\frac{6}{8}+\frac{6}{9}\times\frac{3}{8}=\frac{36}{72}$ = ½ or 0.5 Alt. method: $\frac{6C1\times3C1(\times2)}{9C2(\times2)}$ *oe*	M1 M1 A1 **3**	Mult 2 probs whose numerators sum to 9 o.e. Summing 2 options or mult by 2 (may be 4 options) Correct answer M1 for numerator, M1 for denominator, A1 correct answer
	(iii)	P(5 $\cap$ $\bar{5}$) = $\frac{3}{9}\times\frac{6}{8}=\frac{1}{4}$ P($\bar{5}$) = $\frac{1}{4}+\frac{6}{9}\times\frac{5}{8}$ = 48/72 = 0.6666 P($5_1 \mid \bar{5}_2$) = $\frac{1/4}{48/72}$ = 3/8 = 0.375	M1 M1 A1 A1 **4**	Attempt at P(5 and not 5) seen as numerator or denominator of a fraction Attempt at P(not 5) sum of 2 two-factor terms seen anywhere Correct P($\bar{5}$) as numerator or denominator in fraction Correct answer
	(iv)	<table><tr><td>*x*</td><td>0</td><td>1</td><td>2</td></tr><tr><td>P(*X* = *x*)</td><td>5/12</td><td>1/2</td><td>1/12</td></tr></table> P(0) = P($\bar{5}$, $\bar{5}$) = $\frac{6}{9}\times\frac{5}{8}$ = 30/72 (5/12) (0.4166) P(1) = 0.5 from part (ii) P(2) = 6/72 (1/12) (0.0833) from part (i)	B1 B1 B1ft **3**	Values 0, 1, 2 seen in table with at least 1 prob Correct P(0) unsimplified If *x*=0,1,2(,3) ft Σp = 1, no –ve values, all probabilities <1