1		$P(x < -2.4) = P\left(z < \frac{-2.4-1.5}{3.2}\right)$	M1		Standardising no cc can have sq
		$= P(z < -1.219)$ $= 1 - 0.8886$	M1		Correct area, i.e. < 0.5
		$= 0.111$	A1	**[3]**	Correct answer rounding to 0.111
2	**(i)**	$P(C \cap < 50) = 0.35 \times 0.2 = 0.07$	B1	**[1]**	
	(ii)	$P(C \mid < 50) = \frac{P(C \cap < 50)}{P(< 50)}$	M1	**[4]**	Summing three 2-factor products seen anywhere (can omit the 1)
		$= \frac{0.35 \times 0.2}{0.25 \times 0.3 + 0.35 \times 0.2 + 0.4(\times 1)}$	A1		0.545 (unsimplified) seen as num or denom of a fraction
		$= \frac{0.07}{0.545}$	M1		Attempt at $P(C \cap < 50)$ as 2-factor prod only seen as num or denom of a fraction
		$= 0.128$ (14/109)	A1		Correct answer
3	**(i)**	$z = 0.878$	B1		± 0.878, 0.88, rounding to 0.88 seen
		$\frac{190-160}{\sigma} = 0.878$	M1		(190 – 160)/σ = something
		$\sigma = 34.2$	A1	**[3]**	Correct answer
	(ii)	P(at least 1) = 1 – P(0)	M1		Using 1 – P(0), 1 – P(0, 1), P(1,2 … 12) or P(2, … 12) with $p = 0.19$ or 0.81, terms must be evaluated to get the M1
		$= 1 - (0.81)^{12} = 0.920$	A1	**[2]**	Correct answer accept 0.92
4	**(i)**	number = 1.5 × 50 = 75 (AG)	B1	**[1]**	Must see 1.5 × 50
	(ii)	freqs are 10, 25, 50, 75, 30 (15, 15)	M1 A1		Attempt at freqs not fd Correct freqs
		Mean = (10 × 125 + 25 × 162.5 + 50 × 187.5 + 75 × 225 + 30 × 300)/190	M1		attempt at mid points not cw or ucb or lcb
		= 40562.5/190 = 213 (213.48 …)	A1		correct mean
		$sd^2 = 10 \times 125^2 + 25 \times 162.5^2 + 50 \times 187.5^2 + 75 \times 225^2 + 30 \times 300^2)/190 - (213.48 \ldots)^2$	M1		subst their Σfx^2 in correct variance formula
		sd = 46.5 or 46.6	A1	**[6]**	
	(iii)	have used the mid-point of each interval and not the raw data	B1	**[1]**	

5	**(i)**	$P(4, 5, 6) = (0.22)^4(0.78)^4 8C4 + (0.22)^5(0.78)^3 8C5 + (0.22)^6(0.78)^2 8C6$	M1 M1		Bin term with ${}_8C_r\, p^r\, (1-p)^{8-r}$ seen $r \neq 0$ any $p < 1$ Summing 2 or 3 bin probs $p = 0.22$, $n = 8$
		$= 0.0763$	A1	**[3]**	Correct answer
	(ii)	prob = 0.13 mean = $300 \times 0.13 = 39$ var = $300 \times 0.13 \times 0.87 = 33.93$	B1 B1ft		Correct prob can be implied Correct unsimplified np and npq ft wrong 0.13
		$P(30 < x < 50) = P\left(\frac{30.5-39}{\sqrt{33.93}} < z < \frac{49.5-39}{\sqrt{33.93}}\right)$	M1 M1		Standardising a value need sq rt Cont correction 30.5 / 31.5 or 48.5/49.5 only
		$= P(-1.4592 < z < 1.8026)$ $= \Phi(1.8026) + \Phi(1.4592) - 1$ $= 0.9643 + 0.9278 - 1 = 0.892$	M1 A1	 **[6]**	Correct area $\Phi_1 + \Phi_2 - 1$ oe Rounding to correct answer SC $P(31,..49) = 300C31(0.13)^{31}(0.87)^{269}$ + … +300C49 etc.) B1B1
6	**(i)**	1663200	B1	**[1]**	
	(ii)	M xxxxxxxxx M	M1		9! or 9P9 seen
		Number of ways = $\frac{9!}{3!2!} = 30240$	A1	**[2]**	Correct answer
	(iii)	4 vowels together = $8! \times 4/2!2!$ $= 40320$	M1 M1		8!/2!2! seen mult by something 4 oe 4!/3! or 4C1 etc. seen mult by something
		1663200 – 40320 = 1622880	B1	**[3]**	Correct answer SC 7!/2!2! × 8P4 or 7! × 8P4/3! Or 7!/2!2! × 8P4/3! M1
	(iv)	Exactly 2 Es 4C2 = 6 Exactly 3 Es 4C1 = 4 Total = 10 ways	M1 B1 A1	 **[3]**	Summing 2 options One option correct Correct answer
		OR 5C2 = 10	M2 A1		M1 for k5C2 Correct ans

7	**(i)**	options (3, 4, 4,) or (4, 3, 4) or (4, 4, 3) Probs (4/10 × 6/9 × 5/8) ×3C1 = 360/720 = ½ AG	M1 M1 A1	**[3]**	Summing three 3-factor options oe 10 × 9 × 8 seen in denom Correct answer
		OR $\frac{{}_6C_2 \times {}_4C_1}{{}_{10}C_3} = \frac{1}{2}$ AG	M1 M1 A1		One of 6C2 or 4C1 seen in num 10C3 in denom Correct answer
	(ii)		B1	**[4]**	9, 10, 11, 12 only seen
		P(3, 3, 3) = 4/10 × 3/9 × 2/8 = 24/720 (1/30) P(3, 3, 4) = 4/10 × 3/9 × 6/8 × 3C1 = 216/720 (3/10) P(4, 4, 4) = 6/10 × 5/9 × 4/8 = 120/720(1/6)	B1 B1 B1		One correct prob other than P(11), with or without replacement Another correct prob Σ all 4 probs = 1
	(iii)	P(R) = 0.5 P(S) = 0.4 P($R \cap S$) = 120/720 P($R \cap S$) = 120/720 ≠ P(R) × P(S) Not indep	B1 M1 A1ft	**[3]**	P($R \cap S$) = 120/720 (1/6) Numerical attempt to compare P(R and S) with P(R) × P(S) provided P($R \cap S$) ≠ 1/5 Correct conclusion ft wrong P($R \cap S$) ≠ 1/5, P(S) correct
	(iv)	P($R \cap S$) ≠ 0 or there is an overlap between R and S (34,4) Not exclusive Σxf/Σf	B1ft	**[1]**	Correct answer following correct reasoning ft wrong non zero P($R \cap S$)

sum	9	10	11	12
Prob	24/720	216/720	360/720	120/720