Normal Distribution 2

1	**(a**	$P(X < q + 82) = 0.72$ $z = 0.583$	M1	Rounding to ± 0.58 or ± 0.15 seen
		$\frac{\pm q}{7.4}$ *or* $\frac{\pm 2q}{7.4} = z$ *or probabilty* (o.e.)	M1	Standardising, no cc, no sq, no sq rt
		$q = 4.31$	A1 **3**	correct answer
	(b)	$\frac{0.5\mu - \mu}{\sigma} = \frac{\pm 0.5\mu}{\sigma}$	M1	Standardising attempt some μ/σ allow cc, sq rt, sq Can be implied
		$\frac{0.2\sigma^2}{\sigma} = -0.2\sigma = -0.580$	B1 M1	± 0.580 seen (accept ±0.58) substituting to eliminate μ or σ , arriving at numerical solution, any *z* value or probability – not dependent
		$\sigma = 2.90$ $\mu = 3.36$	A1 **4**	both answers correct , accept 2.9

2	**(i)**	$z = -1.036 = \frac{73 - 75}{\sigma}$ $\sigma = 1.93$	B1 M1 A1 [3]	± correct z value accept ±1.037 Equation with 73, 75, σ and a z value Rounding to correct answer
	(ii)	$P(> 77) = 0.15$ $P(< 3) = P(0, 1, 2)$ $= (0.85)^8 + {}_8C_1(0.15)(0.85)^7 + {}_8C_2(0.15)^2(0.85)^6$ $= 0.895$	M1 M1 **A1** [3	Prob rounding to 0.15 and 0.85 ${}_8C_x p^x(1-p)^{8-x}$ seen any *p*, $0<p<1$ Correct answer

3	**(i**	$z_1 = \frac{12 - 6.4}{5.2} = 1.077$	M1	Standardising, can be all in thousands, no mix, no cc no sq rt no sq
		$z_2 = \frac{10 - 6.4}{5.2} = 0.692$	M1	$\Phi_2 - \Phi_1$, Φ_2 must be $> \Phi_1$
		$\Phi(z_1) - \Phi(z_2) = 0.8593 - 0.7556$ $= 0.104$	A1 [3]	Correct answer
	(ii)	$P(\text{loss}) = P(z < \frac{0 - 6.4}{5.2}) = P(z < -1.231)$ $= 1 - 0.8909$	M1	Standardising using $x = 0$, accept $\frac{0.5 - 6.4}{5.2}$
		$= 0.109$	A1	Correct prob
		$P(1) = (0.1091)^1(0.8909)^3 \times 4C1$	M1	Binomial term ${}_4C_x p^x(1-p)^{4-x}$ any p $x \neq 0$
		$= 0.309$ or 0.308	A1 [4]	Correct answer

4	**(i** $P(9) = P(1,4,4) \times 3 + P(2,3,4) \times 6 + P(3,3,3)$	M1 M1		Listing at least 2 different options Multiplying P(4,3,2) by 6 or P(1,4,4) by 3
	$= 10/64\ (5/32)\ (0.156)$ AG	A1	[3]	Correct answer must see numerical justification
	(ii) probs 1/64, 3/64, 6/64, 10/64, 12/64, 12/64, 10/64, 6/64, 3/64, 1/64.	B1 B1 B1	[3]	3 or more additional correct probs 5 or more correct All correct
	(iii) $P(S) = 6/64(3/32)$	M1 A1		An attempt at P(*S*) 4,4,1 or 4,2,2 Correct P(*S*)
	$P(R \cap S) = 3/64, \neq 15/1024$ ie $P(R) \times P(S)$ OR $P(R\|S) = \frac{3/64}{6/64} = 1/2, \neq 10/64$ ie P(*R*)	B1 M1		Correct $P(R \cap S)$ in either intersection or cond prob cases comparing their $P(R \cap S)$ with their $P(R) \times P(S)$ or their $P(R\|S)$ with their P(*R*) need numerical vals
	Not independent	A1ft	[5]	correct conclusion ft wrong P(*S*) or $P(R \cap S)$ only

5	**(i** $\Phi\left(\frac{84.5-82}{\sqrt{126}}\right) \Phi\left[\frac{83.5-82}{\sqrt{126}}\right]$	M1		Standardising using 83.5 or 84.5, must have square root
	$= \Phi(0.2227) - \Phi(0.1336)$ $= 0.5883 - 0.5533$	M1		Subtracting two probabilities, both > 0.5 or both < 0.5
	$= 0.0350$	A1	**3**	Correct answer
	(ii) $P(x > 87) = 1 - \Phi\left(\frac{87-82}{\sqrt{126}}\right) = 1 - \Phi(0.445)$	M1		Standardising, no cc, must have square root
	$= 1 - 0.6718 = 0.3282$	A1		Correct probability
	$P(0, 1) = (0.6718)^5 + {}_5C_1\,(0.3282)(0.6718)^4$	M1		Any binomial term of form ${}_5C_x p^x (1-p)^{5-x}, x \neq 0$
	$= 0.471$	A1	**4**	Correct answer
	(iii) $P(x < 87) = 0.6718$	M1		Finding $P(x < 87)$, value > 0.5
	$P(x < k) = 0.9718$	M1		Adding 0.3 to their 0.6718 or equivalent
	$z = 1.908$ or 1.909	A1		Correct *z*
	$1.909 = \pm\frac{k-82}{\sqrt{126}}$	M1		Equation with *k*, 82 or 81.5 or 82.5, $\sqrt{126}$, and a *z*-value
	$k = 103$	A1	**5**	Correct answer rounding to 103