Binomial Distribution 2

1 (i	$P(O \text{ given } +) = \frac{0.37}{0.83}(0.4458)$	B1 A1 M1	0.83 seen or implied Attempt to find P(*O* given +) using conditional probability fraction Binomial term ${}^9C_r p^r(1-p)^{9-r}$, $r \neq 0$ or 9
	$P(0, 1, 2) = (0.4458)^0(0.5542)^9 + {}^9C_1(0.4458)^1(0.5542)^8 + {}^9C_2(0.4458)^2(0.5542)^7$	M1 A1	Binomial expression P(0, 1, 2) or P(0, 1, 2, 3) powers summing to 9 any $0 < p < 1$ Correct unsimplified expression
	$= 0.156$	A1 [6]	Correct final answer
(ii)	$\mu = 150 \times 0.35 = 52.5$,	B1	150×0.35 (52.5) and $150 \times 0.35 \times 0.65$ (34.125) seen
	$\sigma^2 = 150 \times 0.35 \times 0.65 = 34.125$	M1 M1	Standardising, using sd not variance Using continuity correction, 59.5 or 60.5
	$P(> 60.5) = P\left(z > \pm\frac{60.5 - 52.5}{\sqrt{34.125}}\right)$	M1	correct area (< 0.5, for mean < their 60)
	$= 1 - \Phi(1.369)$		
	$= 0.0854$ or 0.0855	A1 [5]	correct value

2 (i	If y = P(odd number) then P(even number) = $2y$ $3y + 6y = 1$ so $y = 1/9$ oe. OR prob = 1/3	M1 A1 [2]	2P(Odd) shown = P(Even) and summed to 1 correct answer accept either
(ii)	Score of 8 means throwing a 6 6 is even so P(8) = 2/9 (AG)	B1 B1 [2]	 legit justification of use of 2/9
(iii)	$\text{Var}(X) = (48 + 36 + 98 + 128 + 100)/9 - (58/9)^2$ $= 4.02$ accept 4.025 (326/81)	M1 A1 [2]	Correct method no dividings, 6.44 squared subt numerically Correct answer
(iv)	P(score 6,10) + P(score 10,6) + P(score 8,8) = 1/81 + 1/81 + 4/81 = 6/81 (2/27) (0.0741)	M1 A1 [2]	Summing two different 2-factor probabilities Correct answer
(v)	P(score 6, 10) = 1/81 P(1st score 6 given total 16) = (1/81) ÷ (6/81) = 1/6	B1 M1 A1 [3]	1/81 seen in numerator Dividing by their **(iv)** Correct answer

3	**(i** constant/given prob, independent trials, fixed/given no. of trials, only two outcomes	B1 B1 [2]	One option correct Three options correct
	(ii) P(8, 9, 0, 1) = ${}^9C_8(0.3)^8(0.7) + (0.3)^9 + (0.7)^9 + {}^9C_1(0.3)(0.7)^8$ = 0.196	M1 A1 A1 [3]	One term seen involving $(0.3)^x(0.7)^{9-x}({}^9C_x)$ Correct unsimplified expression Correct answer
	(iii) mean = 90 × 0.3 = 27 var = 18.9 $P(X > 35) = 1 - \Phi\left(\frac{35.5-27}{\sqrt{18.9}}\right)$ = 1 – Φ(1.955) = 0.0253 $P(X < 27) = \Phi\left(\frac{26.5-27}{\sqrt{18.9}}\right) = 1 - \Phi(0.115)$ = 0.4542 Total prob = 0.480 accept 0.48	B1 M1 M1 M1 A1 [5]	Expressions for 27 and 18.9 (4.347) seen Standardising one expression, must have sq rt in denom, cc not necessary Continuity correction applied at least once $(1 - \Phi_1) + (1 - \Phi_2)$ accept (0.0329 + 0.5) if no cc Rounding to correct answer

4	Normal mean 60 kg, variance 90 kg^2	B1 B1 [2]	Any sensible values (mean 40–80 kg, variance 16–225 kg^2), could give s.d. 4–15 kg

5	$20p = 1.6 \quad p = 0.08$	M1 A1	Equation relating $20p$ to the mean Correct p can be implied
	$P(X > 2) = 1 - \{(0.92)^{20} + {}^{20}C_1(0.08)(0.92)^{19} + {}^{20}C_2(0.08)^2(0.92)^{18}\}$	M1	Bin expression involving $p^x(1-p)^{20-x}\ {}^{20}C_x$ any p
	= 1 – (0.1887 + 0.3281 + 0.2711)	M1	Subtracting 2 or 3 binomial probs from 1, one of which is P(0)
	= 0.212	A1 **[5]**	Correct answer

6 P(total 7) = P(3,4 or 4,3) = 2/16 P(total 8) = P(4,4) = 1/16 P(7 or more) = 3/16 Expected $200 \times \frac{3}{16} = 37.5$	M1 A1 M1 A1ft **[4]**	Attempt to find P(7) + P(8) 3/16 seen Multiplying their prob by 200 Correct final answer ft their prob

7 (i	$P(X > 0) = 1 - \Phi\left(\frac{0 - -15.1}{\sqrt{62}}\right)$	M1		Standardising, sq rt, no cc
	$= 1 - \Phi\ (1.918)$ $= 1 - 0.9724$	M1		Prob < 0.5 after use of normal tables
	= 0.0276 or answer rounding to	A1	**[3]**	Correct answer
(ii)	$z = -1.22$	B1		$z = \pm 1.22$
	$-1.22 = \frac{0 - \mu}{\sqrt{40}}$	M1		an equation in μ, recognisable z, $\sqrt{40}$, no cc
	$\mu = 7.72$ c.a.o	A1	**[3]**	correct answer c.w.o from same sign on both sides