Normal Distribution 1 MS

Q1.

3	(+/–) 1.045, (+/–) 0.313	B1, B1	1 correct z-value, the other correct z-value.
	$20.9 - \mu = -0.313\ \sigma$ $30 - \mu = 1.045\ \sigma$	M1	Valid attempt to solve 2 equations relating to μ, σ, 30, 20.9. No $\sqrt{\sigma}$, σ^2
	$\sigma = 6.70$ $\mu = 23.0$	A1 A1 **[5]**	correct answer correct answer

Q2.

5	**(i)** $P(X = 2)) = (0.25)^2 \times (0.75)^6 \times {}^8C_2$	M1	3 term binomial expression involving ^8C something, powers summing to 8
	$= 0.311$	A1 **[2]**	correct answer
	(ii) $12 \times 0.25 = 3, < 5$ so not possible	B1 **[1]**	
	(iii) mean $= 40 \times 0.25\ (= 10)$ variance $= 40 \times 0.25 \times 0.75\ (= 7.5)$	B1	40×0.25 and $40 \times 0.25 \times 0.75$ seen, o.e.
	$P(X \text{ at least } 13) = P\left(z > \frac{12.5 - 10}{\sqrt{7.5}}\right)$	M1	standardising, ±, with or without cc, must have sq rt
	$= P(z > 0.913)$ $= 1 - \Phi(0.913)$ $= 1 - 0.8194$ $= 0.181$	M1 M1 A1 **[5]**	continuity correction 12.5 or 13.5 correct area, i.e. < 0.5 legit correct answer

Q3.

2	**(i)** $P(x > 10.9) = P(z > \frac{10.9 - 11}{0.095})$	M1	Standardising, no cc, no sq rt
	$= P(z > -1.0526)$ $= 0.8538\ (0.854)$	A1 **[2]**	Rounding to correct answer
	(ii) P(at least 2 < 10.9) = 1 – P(0, 1)	M1	Bin expression with $\sum$ powers = 6, ^6C_x, $p + q = 1$.
	$= 1 - (0.8538)^6 - {}^6C_1(0.1462)(0.8538)^5$	A1ft	Reasonably correct unsimplified expression ft their **(i)**
	$= 0.215$	A1 **[3]**	Rounding to correct answer

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Q4.

4	**(i)** $P(X < 2\mu) = P\left(z < \frac{2\mu - \mu}{\sigma}\right)$	M1	Standardising, and attempt to get 1 variable, no cc, no $\sqrt{}$, no sq
	$= P(z < \mu/\sigma) = P(z < 5/3)$	A1	±5/3 seen oe
	$= 0.952$	A1 **[3]**	Rounding to correct answer
	(ii) $P\left(X < \frac{\mu}{3}\right) = P\left(z < \frac{-2\mu}{3\sigma}\right)$	M1	standardising attempt resulting in $z \leqslant -$ some μ/σ allow $\pm\left(\frac{\mu/3 - \mu}{\sigma}\right)$
	$\frac{-2\mu}{3\sigma} = 1.047$	B1	±1.047 seen
	$\mu = -1.57\sigma$	A1 **[3]**	correct single number, answer must have a minus sign and $\mu =$ …..σ

Q5.

7	**(i)** $0.431 = \frac{135 - \mu}{\sigma}$	B1	One ±z-value correct, accept 0.430
		B1	A second ±z-value correct
	$-0.842 = \frac{127 - \mu}{\sigma}$	M1	Solving two equations relating μ, σ, 135, 127 and their z-values (must be z-values)
	$\sigma = 6.29$	A1	Correct answer accept 6.28
	$\mu = 132$	A1 [5]	Correct answer
	(ii) $P(X < 145) = P\left(z < \frac{145 - 132.3}{6.284}\right)$	M1	Standardising no sq rt no cc
	$= P(z < 2.023)$	M1	Correct use of normal tables
	$= 0.978$	A1 [3]	Answer rounding to 0.978 or 0.979
	(iii) $p = 1/3$		
	P(at least 2) = 1 – P(0, 1)	M1	Binomial expression with powers summing to 8 and ${}^{8}C_{\text{something}}$. (any p)
	$= 1 - [(2/3)^8 + {}^8C_1 \times (1/3)^1 (2/3)^7]$	A1	Correct unsimplified expression
	$= 0.805$	A1 [3]	Answer rounding to 0.805

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Q6.

3 (i)	$P(X > 20) = P(z > -6.4/3.7)$ $= P(z > -1.730)$ $= 0.9582$	M1 A1	Standardising no cc no sq rt Prob rounding to 0.958
	Number of students = 335 or 336	A1ft [3]	Correct answer ft their prob, must be integer
(ii)	P(very slow) = 0.05	B1	0.05 or 0.95 seen
	P(0, 1, 2) = $(0.95)^8 + {}^8C_1(0.05)^1(0.95)^7 + {}^8C_2(0.05)^2(0.95)^6$	M1	Binomial term with ${}^8C_r p^r (1-p)^{8-r}$ seen any p
	$= 0.6634 + 0.2793 + 0.0515$ $= 0.994$	M1 A1 [4]	Correct expression for P(0, 1, 2), p close to 0.05 Answer rounding to 0.994

Q7.

5 (i)	Zotoc: $z = \frac{367 - 320}{21.6} = 2.176$ Ganmor: $z = \frac{367 - 350}{7.5} = 2.267$	M1	Standardising either car's fuel, no cc, no sq, no √
	P(Zotoc) = 0.985	A1	Correct answer
	P(Ganmor) = 0.988	A1 [3]	Correct answer
(ii)	$z = 0.23$ $0.23 = \frac{x - 320}{21.6}$	B1 M1	± 0.23 seen Standardising either car, no cc, no sq rt, no sq
	$x = 324.968$	M1ind	$320 + d - 320$ i.e. just d on num
	$d = 4.97$	A1 [4]	Correct answer, –4.97 gets A0

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Q8.

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

Q9.

7	**(i)** $z = 0.807$	B1	0.807 seen
	$0.807 = \frac{10 - 8.2}{\sigma}$	M1	standardising, must have σ, no sq rt, no cc and a z-value
	s = 2.23	A1 [3]	correct answer
	(ii) P(> 1 min from mean) = $P(\text{mod } z > \frac{1}{2.23})$	M1	standardising, their sd, no cc and adding two areas
	$= P(\lvert z \rvert > 0.4484)$ $= (1 - 0.6729) \times 2$ $= 0.654$	M1 A1 [3]	using $1 - \Phi(z)$ correct answer
	(iii) P(> 2 longer) = 1 – P(0, 1, 2 longer)	M1	binomial term ${}^6C_x p^x(1-p)^{6-x}$
	$= 1 - \{(0.79)^6 + {}^6C_1(0.21)(0.79)^5 + {}^6C_2(0.21)^2(0.79)^4\}$	A1	correct unsimplified answer
	$= 0.112$	A1 [3]	correct answer

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(iv) $\mu = 35 \times 0.5 = 17.5$ $\sigma^2 = 35 \times 0.5 \times 0.5 = 8.75$	B1	17.5 and 8.75 or $\sqrt{8.75}$ seen
$P(X < 16) = \Phi\left(\frac{15.5 - 17.5}{\sqrt{8.75}}\right)$	M1 M1	standardising, with or without cc, must have sd in denom continuity correction 15.5 or 16.5 only, seen
$= 1 - \Phi(0.676)$ $= 1 - 0.7505$ $= 0.2495$ (0.249 or 0.250)	M1 A1 [5]	using $1 - \Phi(z)$ correct answer
OR ${}^{35}C_0 0.5^0 0.5^{35} + {}^{35}C_1 0.5^1 0.5^{34} + {}^{35}C_2 0.5^2 0.5^{33} + \ldots$ $= 8582372584/2^{35} = 0.250$	M1 A1 M1 A1 A1	binomial term ${}^{35}C_x 0.5^x 0.5^{35-x}$ at least 2 correct terms ($x \neq 0$) seen summing 16 or 17 terms correct expression correct answer

Q10.

5 (a) $z > \frac{2\mu - \mu}{\sigma} = \frac{\mu}{\sigma} = \frac{7\sigma^2}{3\sigma}$	M1	Standardising attempt resulting in $z >$ some μ/σ
$\frac{7\sigma}{3} = 1.272$	M1 B1	Substituting to eliminate μ or σ 1.272 seen
$\sigma = 0.545$ $\mu = 0.693$	A1 **[4]**	Both answers correct
(b) $P(X < a + 33) = 0.75$ $z = 0.674$	M1 A1	Using 0.75 oe ± 0.674 seen
$\frac{a + 33 - 33}{\sqrt{21}} = 0.674$	M1	Standardising, no cc, must have sq rt
$a = 3.09$	A1 **[4]**	Correct answer