

## Normal Distribution 2 MS

Q1.

<p><b>2 (i)</b> <math>np = 24, npq = 4.8</math></p> $z = \pm \left( \frac{24.5 - 24}{\sqrt{4.8}} \right) = 0.228$ <p>Prob = 0.590</p>	<p>B1</p> <p>M1</p> <p>M1</p> <p>A1 [4]</p>	<p>24 and 4.8 or <math>\sqrt{4.8}</math> seen can be unsimplified</p> <p>Standardising, need sq rt, cc not necessary</p> <p>Continuity correction 24.5 or 25.5 used</p> <p>Correct answer must be from 24.5</p>
<p><b>(ii)</b> <math>np</math> and <math>nq</math> both <math>&gt; 5</math>.</p>	<p>B1 [1]</p>	<p>Need both</p>

Q2.

<p><b>6 (i)</b> <math>z = -1.282</math></p> $P(x < 20) = P\left(z < \frac{20 - \mu}{0.8}\right)$ $-1.282 = \frac{20 - \mu}{0.8}$ $\mu = 21.0 \text{ cm (21.0256)}$	<p>B1</p> <p>M1</p> <p>A1 [3]</p>	<p><math>\pm 1.282</math> or <math>\pm 1.281</math> seen</p> <p>Standardising, no cc, must have 0.8, must be a z-value</p> <p>Correct answer</p>
<p><b>(ii)</b> <math>P(21.5 &lt; x &lt; 22.5)</math></p> $= P\left(\frac{21.5 - 21.03}{0.8} < z < \frac{22.5 - 21.03}{0.8}\right)$ $= \Phi(1.8375) - \Phi(0.5875)$ $= 0.9670 - 0.7217$ $= 0.2453$ <p><math>P(&lt; 2) = P(0) + P(1)</math></p> $= (0.7547)^4 + (0.2453)^1(0.7547)^3 {}^4C_1$ $= 0.746$	<p>M1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>M1</p> <p>A1 [6]</p>	<p>2 attempts at standardising with their mean, must have 0.8 oe</p> <p>Subtracting 2 <math>\Phi</math>s ft their mean</p> <p>Needn't be entirely accurate, rounding to 0.24 or 0.25</p> <p>Binomial term with <math>{}^4C_r p^r (1-p)^{4-r}</math> seen</p> <p><math>r \neq 0</math>, any <math>p &lt; 1</math></p> <p>Bin expression for <math>P(0) + P(1)</math>, any <math>p &lt; 1</math></p> <p>Accept 3sf rounding to 0.75</p>

## Normal Distribution 2 MS

Q3.

<p><b>5 (i)</b> <math>z = \pm 1.751</math>  <math>\pm \frac{20 - \mu}{\mu/4} = 1.751</math>  <math>\mu = 13.9</math></p>	B1	Correct z
	M1	Standardising no cc, no sqrt, must be a z-value
	A1	Correct answer
<p><b>(ii)</b> <math>P(X &lt; 10) = P(z &lt; \pm \frac{10 - 13.91}{13.91/4})</math>  <math>= P(z &lt; -1.124)</math>  <math>= 1 - 0.8694</math>  <math>= 0.131</math>  <math>P(10 &lt; X &lt; 20) = 0.96 - 0.131</math>  <math>= 0.829</math> or <math>0.830</math></p>	M1	Standardising attempt with 10, their $\mu$ and their $\mu/4$ , no cc, no sqrt
	M1	“ $\Phi_1 + \Phi_2 - 1$ ”, ft their mean
	A1	Correct answer
<p><b>(iii)</b> <math>\mu = 250 \times 0.96 = 240</math>  <math>\sigma^2 = 250 \times 0.96 \times 0.04 = 9.6</math>  <math>P(\geq 235) = 1 - \Phi\left(\pm \frac{234.5 - 240}{\sqrt{9.6}}\right)</math>  <math>= \Phi(1.775)</math>  <math>= 0.962</math></p>	B1	240 and 9.6 or sq rt 9.6 seen unsimplified
	M1	Standardising, with or without cc, must have sq rt in denom
	M1	Continuity correction 234.5 or 235.5 only
	M1	Correct region $> 0.5$ , ft their mean
	A1	Correct answer

Q4.

<p><b>1</b> <math>\mu = 250 \times 0.86 = 215</math>  <math>\sigma^2 = 250 \times 0.86 \times 0.14 = 30.1</math>  <math>P(X &gt; 210) = 1 - \Phi\left(\frac{210.5 - 215}{\sqrt{30.1}}\right)</math>  <math>= \Phi(0.820)</math>  <math>= 0.794</math></p>	B1	250 $\times$ 0.86 and 250 $\times$ 0.86 $\times$ 0.14 seen o.e
	M1	Standardising, with or without cc, must have sq rt in denom
	M1	Continuity correction 210.5 or 209.5 only
	M1	Correct region ( $> 0.5$ ) ft their mean
	A1	Correct answer

## Normal Distribution 2 MS

Q5.

<b>5 (i)</b> $z = 1.882$ or $1.881$ $1.882 = (32 - 20) / \sigma$ $\sigma = 6.38$	B1		$\pm 1.882$ or $\pm 1.881$ seen
	M1		Equation using their $z$ (must be a $z$ -value) 32, 20 and $s$
	A1	[3]	Correct answer
<b>(ii)</b> $P(x > 13) = P\left(z > \frac{13 - 20}{6.376}\right)$ $= P(z > -1.0978)$ $= 0.864$	M1		Standardising
	M1		Correct area $> 0.5$
	A1	[3]	Correct answer
<b>(iii)</b> $P(\text{at least } 2) = 1 - P(0, 1)$ $= 1 - (0.97)^7 - (0.03)(0.97)^6 \cdot C_1$ $= 0.0171$	M1		Using 0.03 and 0.97 or 0.06 and 0.94 in a binomial expression powers summing to 7
	M1		Correct unsimplified binomial expansion
	A1	[3]	Correct answer

Q6.

<b>5 (i)</b> $4p + p + 3p = 1$ so $P(\text{blue}) = 1/8$ AG <b>(ii)</b> $P(R) = 1/2, P(B) = 1/8, P(G) = 3/8$ $P(\text{all different}) = 1/2 \times 1/8 \times 3/8 \times 3!$ $= 9/64$ (0.141)	B1	[1]	Must show something
	M1	[3]	Multiplying $P(R, B, G)$ together
	M1		Mult by 3!
<b>(iii)</b> mean = $136 \times 1/8 = 17$ , var = 14.875 $P(< 20) = P\left(z < \frac{19.5 - 17}{\sqrt{14.875}}\right)$ $= \Phi(0.648)$ $= 0.742$	A1		Correct answer
	B1		Unsimplified mean and variance correct
	M1		Standardising, need sq rt
	M1		Cont correction 19.5 or 20.5
	M1		Correct area, $> 0.5$ legit
A1	[5]		Correct answer

## Normal Distribution 2 MS

Q7.

<b>7 (i)</b> $z_1 = \frac{12-8}{\sqrt{24}} = 0.816$ $\Phi_1(0.816) = 0.7926$ $z_2 = \frac{7-8}{\sqrt{24}} = -0.204$ $\Phi_2(-0.204) = 1 - 0.5808$ Prob = $0.7926 - (1 - 0.5808) = 0.373$	M1		Standardising any one, sq rt, no cc
	M1		Correct area $\Phi_1 + \Phi_2 - 1$
	A1	[3]	Correct answer
<b>(ii)</b> $z = \frac{0-\mu}{2\mu} = -0.5$ $P(z < -0.5) = 1 - 0.6915$ $= 0.309$ or 30.9%	M1		Standardising, no cc no sq rt, one variable
	A1	[2]	Correct answer oe
<b>(iii)</b> $z = \frac{3\mu-\mu}{2\mu} = 1$ $P(z > 1) = 1 - 0.8413 = 0.1587$ $70 \times 0.1587 = 11.1$	M1		Standardising and eliminating $\mu$
	M1		Subt from 1 and multiplying by 70
	A1	[3]	Correct answer accept 11 or 12
<b>(iv)</b> $z = 1.45$ $1.45 = \frac{6-\mu}{2\mu}$ $\mu = 1.54$	B1		$\pm 1.45$ seen
	M1		Solving for $\mu$ with 6, $2\mu$ , $\mu$ and their $z$
	A1	[3]	Correct answer

Q8.

<b>1 (i)</b> $z = 0.38$ $\pm \frac{25-\mu}{\mu/3} = 0.38$  $\mu = 22.2, \sigma = 7.40$	B1		$\pm 0.38(0)$ seen or implied
	M1		Standardising attempt resulting in $z =$ some $\mu/\sigma$ /both, no continuity correction
	M1		Substituting to eliminate $\mu$ or $\sigma$ and attempt to solve linear equation
	A1	[4]	Both correct
<b>(ii)</b> $P(4) = {}^6C_4(0.352)^4(0.648)^2$ $= 0.0967$	M1		${}^6C_r \times (p)^r \times (1-p)^{6-r}, r = 2$ or 4
	A1	[2]	Correct answer

Q9.

<b>1</b> $z_1 = \frac{30-28.3}{\sqrt{4.5}} = 0.8014$ $z_2 = \frac{25-28.3}{\sqrt{4.5}} = -1.5556$ $\Phi_1 - (1 - \Phi_2) = 0.7884 + 0.9401 - 1$ $= 0.729$	M1		Standardising at least one value, sq rt.ess; no cc
	M1		$\Phi_1 + \Phi_2 - 1$ oe
	A1	[3]	Correct answer

## Normal Distribution 2 MS

Q10.

<p><b>6 (i)</b> <math>-1.253 = \frac{6 - \mu}{\sigma}</math></p> <p><math>0.648 = \frac{12 - \mu}{\sigma}</math></p> <p><math>\mu = 9.9</math>  <math>\sigma = 3.15</math> or <math>3.16</math></p>	<p>B1</p> <p>B1</p> <p>M1</p> <p>M1</p> <p>[Indpt]</p> <p>A1 <b>[5]</b></p>	<p><math>Z = \pm 1.253</math></p> <p><math>Z = \pm 0.648</math></p> <p>Any equation with <math>\mu</math> and <math>\sigma</math> and a reasonable <math>z</math> value not a prob. Allow cc or -, not <math>\sqrt{\sigma}</math> or <math>\sigma^2</math></p> <p>Att. to solve by substitution or elimination</p>
<p><b>(ii)</b> need <math>P(z &lt; -1</math> or <math>z &gt; 1)</math>  <math>= 1 - \Phi(1) + \Phi(-1)</math>  <math>= 2 - 2 \times 0.8413</math>  <math>= 0.3174</math>          number = 317</p>	<p>B1</p> <p>M1</p> <p>M1</p> <p>A1 <b>[4]</b></p>	<p><math>z = 1</math> or <math>-1</math> seen</p> <p>Correct area i.e. <math>2 - 2\Phi</math></p> <p>Mult their prob if sensible, by 1000</p> <p>Accept 317, 317.4, 318</p>