

## Binomial Distribution 3

<p>1 (i) <math>(0.6)^{10} \times (0.4)^{10} \times {}_{20}C_{10}</math>  <math>= 0.117</math></p>	M1		3 term binomial expression involving ${}_{20}C_{\text{something}}$ and powers summing to 20
	A1	<b>2</b>	Correct final answer
<p>(ii) <math>P(18, 19, 20)</math>  <math>= (0.6)^{18} (0.4)^2 {}_{20}C_2 + (0.6)^{19} (0.4)^1 {}_{20}C_1</math>  <math>+ (0.6)^{20}</math>  <math>= 0.003087 + 0.000487 + 0.00003635</math>  <math>= 0.00361</math></p> <p>OR using normal approx <math>N(12, 4.8)</math>  <math>z = \frac{17.5 - 12}{\sqrt{4.8}}</math>  <math>= 2.51</math></p> <p>Prob = <math>1 - 0.9940 = 0.0060</math></p>	M1	A1	Summing three or 4 binomial expressions One correct unsimplified expression allow 0.4 0.6 muddle
	A1	A1	Correct answer
	M1	A1	Standardising, cc 16.5 or 17.5, their mean, $\sqrt{\quad}$ (their var)
	A1	A1	2.51 seen
	A1	<b>3</b>	0.0060 seen must be 0.0060
<p>(iii) <math>\mu = 150 \times 0.60 = 90</math>  <math>\sigma^2 = 150 \times 0.60 \times 0.40 = 36</math>  <math>P(88 &lt; X &lt; 97)</math>  <math>= \Phi\left(\frac{97.5 - 90}{6}\right) - \Phi\left(\frac{87.5 - 90}{6}\right)</math>  <math>= \Phi(1.25) - \Phi(-0.4166)</math>  <math>= 0.8944 - (1 - 0.6616)</math>  <math>= 0.556</math></p>	B1	M1	For seeing 90 and 36
	M1	M1	For standardising, with or without cc, must have sq rt on denom
	M1	A1	one continuity correction 97.5 or 96.5 or 87.5 or 88.5
	A1	M1	0.8944 or 0.6616 or 0.3384 or 0.3944 or 0.1616 seen
	M1	A1	subtracting a probability from their standardised 97 prob
	A1	<b>6</b>	correct answer

<p>2 (i) <math>P(\text{no orange}) = (2/3)^5</math> or 0.132 or 32/243</p>	<p>B1 1</p>	<p>For correct final answer either as a decimal or a fraction</p>
<p>(ii) <math>P(2 \text{ end in } 6) = (1/10)^2 \times (9/10)^3 \times {}_5C_2</math>  <math>= 0.0729</math></p>	<p>B1 M1  A1 3</p>	<p>For using <math>(1/10)^k \quad k &gt; 1</math> For using a binomial expression with their 1/10 or seeing some <math>p^2 * (1-p)^3</math> For correct answer</p>
<p>(iii) <math>P(2 \text{ orange end in } 6) = (1/30)^2 \times (29/30)^3 \times {}_5C_2</math>  <math>= 0.0100</math> accept 0.01</p>	<p>M1  A1 2</p>	<p>For their <math>(1/10)/3</math> seen  For correct answer</p>
<p>(iv) <math>n = 5, p = 1/3,</math> mean = 5/3, variance = 10/9</p>	<p>B1 B1 ft 2</p>	<p>For recognising <math>n=5, p = 1/3</math> For correct mean and variance, ft their <math>n</math> and <math>p, p &lt; 1</math></p>

<p>3 (i) constant p, independent trials, fixed number of trials, only two outcomes</p>	<p>B1  B1 2</p>	<p>For an option  For a second option</p>
<p>(ii) <math>P(X &lt; 4) =</math>  <math>0.72^{14} + {}_{14}C_1 \times 0.28 \times 0.72^{13}</math>  <math>+ {}_{14}C_2 \times 0.28^2 \times 0.72^{12}</math>  <math>+ {}_{14}C_3 \times 0.28^3 \times 0.72^{11}</math>   <math>(= 0.0101 + 0.0548 + 0.1385 + 0.2154)</math>   <math>= 0.419</math></p>	<p>M1  M1  A1  A1 4</p>	<p>For adding with some C in <math>P(0 + 1 + 2 + 3)</math> or <math>P(1 + 2 + 3)</math> or <math>P(0 + 1 + 2 + 3 + 4)</math> or <math>P(1 + 2 + 3 + 4)</math>  For 0.28 and 0.72 to powers which sum to 14  Need 2 or more terms  For completely correct unsimplified form  For correct final answer  <b>NB</b> 0.418 is A0 if PA # 1 or A1 if PA # 2</p>

<p><b>(iii)</b> <math>\mu = 50 \times 0.28 (= 14)</math></p> <p><math>\sigma^2 = 50 \times 0.28 \times 0.72 (= 10.08)</math></p> <p><math>P(\text{more than } 18) = 1 - \Phi\left(\frac{18.5 - 14}{\sqrt{10.08}}\right)</math></p> <p><math>= 1 - \Phi(1.417)</math></p> <p><math>= 1 - 0.9218 \text{ or } 0.9217</math></p> <p><math>= 0.0782 \text{ or } 0.0783</math></p>	<b>B1</b>	For 14 and 10.08 seen, can be implied
	<b>M1</b>	For standardising with or without cc, must have sq root
	<b>M1</b>	For continuity correction 17.5 or 18.5 AND a final answer < 0.5
	<b>A1</b> <b>4</b>	For correct answer
		NB 0.078 is A0 if RE # 1 or A1 if RE # 2

<p><b>4 (i)</b> <math>(0.95)^5</math> <math>= 0.774</math></p>	M1	For 0.95 seen, can be implied
	A1 <b>2</b>	For correct final answer
<p><b>(ii)</b> <math>(0.95)^4 \times (0.05)^1 \times {}_5C_1</math></p> <p><math>= 0.204</math></p>	M1	For any binomial calculation with 3 terms, powers summing to 5
	A1 <b>2</b>	For correct answer
<p><b>(iii)</b> <math>(0.95)^2 \times (0.05)</math></p> <p><math>= 0.0451(361/8000)</math></p>	M1	For no Ps, no Cs, and only 3 terms of type $p^2(1-p)$
	A1 <b>2</b>	For correct answer

<p>5 (i) <math>P(\text{equal}) = (0.25)^5 \times (0.75)^5 \times {}_{10}C_5</math>  <math>= 0.0584</math></p>	<p>M1 A1 2</p>	<p>For <math>(0.25)^5 \times (0.75)^5</math> must be 0.25, 0.75 For correct answer. A0 if subsequently doubled</p>
<p>(ii) <math>(0.0584)^1 \times (0.9416)^7 \times {}_8C_1</math>  <math>= 0.307</math></p>	<p>M1 A1ft 2</p>	<p>For <math>(\text{their}(a))^1 \times (1 - \text{their}(a))^7 \times {}_8C_1</math> For correct answer from their ans to (i) Accept anything from 0.304 to 0.307 for the ft if they have lost the A1 in (i) from PA</p>
<p>(iii) <math>\mu = 120 \times 0.25 = 30, \sigma^2 = 30 \times 0.75 = 22.5</math></p> $P(X < 35) = \Phi\left(\frac{34.5 - 30}{\sqrt{22.5}}\right) = \Phi(0.949)$ <p><math>= 0.829</math></p>	<p>M1 M1 B1 M1 A1 5</p>	<p>For both mean and variance correct from any sensible p For correct standardisation with or without cc For correct use of continuity correction 34.5 For use of tables based on their z value either end NB can't get if z is too large or too small For correct answer</p>

<p>6 (i)</p>	<p><math>P(5, 6, 7) = {}^8C_5(0.68)^5(0.32)^3 +</math>  <math>{}^8C_6(0.68)^6(0.32)^2 + {}^8C_7(0.68)^7(0.32)</math>  <math>= 0.722</math></p>	<p>M1 M1 A1 A1 [4] Binomial term <math>{}^8C_x p^x(1-p)^{8-x}</math> seen <math>0 &lt; p &lt; 1</math> Summing 3 binomial terms Correct unsimplified answer Correct answer</p>
<p>(ii)</p>	<p><math>np = 340, npq = 108.8</math></p> $P(x > 337) = P\left(z > \frac{337.5 - 340}{\sqrt{108.8}}\right)$ <p><math>= P(z &gt; -0.2396)</math>  <math>= 0.595</math></p>	<p>B1 M1 M1 M1 A1 [5] Correct (unsimplified) mean and var standardising with sq rt must have used 500 cc either 337.5 or 336.5 correct area (<math>&gt; 0.5</math>) must have used 500 correct answer</p>
<p>(iii)</p>	<p><math>np(340) &gt; 5</math> and <math>nq(160) &gt; 5</math></p>	<p>B1 [1] must have both or at least the smaller, need numerical justification</p>