

Binomial Distribution Exam Questions MS (From OCR Legacy S1)

Q1 (Jan 2006, Q7)

7(i)	Binomial $n = 10, p = 0.9$ Each seed equally likely germ or P(germ) same for all seeds oe Seeds independent oe	B1 B1 B1 B1 4	Both requ'd. Ignore $q = 0.1$ or seeds grown in same conditions Context nec'y for each B1
(ii)	0.0702 (3 sfs)	B2 2	0.07 or 0.2639: B1 Σ or $1-\Sigma$: 1 term extra or omit or wrong: M1
(iii)	$1 - \text{"0.0702"}$ $0.9298^{20} + {}^{20}C_1 \times 0.0702 \times 0.9298^{19}$ $= 0.585$ (3 sfs)	M1 M1M1 A1 4	Or 0.9298 or 0.93(0) seen M1 each term cao eg ft (ii) 0.2639 \rightarrow (iii) 0.0178 from correct wking: M3A0 $0.0702^{20} + {}^{20}C_1 \times 0.9298 \times 0.0702^{19}$ ($= 2.25 \times 10^{-21}$): SC M1M1 NB ft (ii) for all M mks. But if 0.1, 0.9 used, must be clear using (ii) rounded

Q2 (Jun 2010, Q4) [Modified]

4ia	0.299 (3 sf)	B1 1	
ib	$0.2991 - 0.1040$ $= 0.195$ (3 sf) or $\frac{1280}{6561}$ oe	M1 A1 2	Must subtract correct pair from table
iaa	${}^{15}C_4 \times (1-0.22)^{11} \times 0.22^4$ $= 0.208$ (3 sf)	M1 A1 2	Allow M1 for ${}^{15}C_4 \times 0.88^{11} \times 0.22^4$
iib	$(15 \times 0.22 =) 3.3$ $15 \times 0.22 \times (1-0.22)$ or $'3.3' \times (1-0.22)$ $= 2.57$ (3 sf)	B1 M1 A1 3	Allow M1 for $15 \times 0.22 \times 0.88$

Q3 (Jun 2011, Q3) [Modified]

3ia	$(1 - 0.5565)$ or $12 \times 0.85^{11} \times (1 - 0.85) + 0.85^{12}$ = 0.4435 or 0.443 or 0.444 (3 sf)	M1 A1 2	or $1 - ((1 - 0.85)^{12} \dots {}^{12}C_{10} \times 0.85^{10} (1 - 0.85)^2)$ ie 1 - (all 11 correct binomial terms)
b	$0.5565 - 0.2642$ or ${}^{12}C_{10} (1 - 0.85)^2 (0.85)^{10}$ = 0.2923 or 0.2924 or 0.292 (3 sf)	M1 A1 2	
c	$12 \times 0.85 \times (1 - 0.85)$ = 1.53 oe	M1 A1 2	
ii	$(\frac{3}{4})^2$ AND $\frac{3}{4} \times \frac{1}{4}$ seen (possibly $\times 2$) $(\frac{3}{4})^2 \times 2 \times \frac{3}{4} \times \frac{1}{4}$ oe or $\frac{27}{128}$ or 0.211 $2 \times (\frac{3}{4})^2 \times 2 \times \frac{3}{4} \times \frac{1}{4}$ oe = $\frac{27}{64}$ or 0.422 (3 sfs)	M1 M1 M1 A1 4	eg $(\frac{3}{4})^2 + \frac{3}{4} \times \frac{1}{4}$ or $2 \times (\frac{3}{4})^2 + 2 \times \frac{3}{4} \times \frac{1}{4}$ or 0.5625 + 0.1875 or 0.5625 + 0.375 or eg 0.5625 \times 0.375 Fully correct method

Q4 (Jun 2013, Q7)

(i)	(a)	$X \sim B(30, 0.05)$ seen or implied $P(X > 2) = 1 - 0.8122$ alone or $1 - (0.95^{30} + 30 \times 0.95^{29} \times 0.05 + {}^{30}C_2 \times 0.95^{28} \times 0.05^2)$ = 0.1878 or 0.188 (3 sfs)	1 B1 M1 A1 [3]	eg by 0.8122 or $1 - 0.5535$ or $0.95^r \times 0.05^s$ ($r, s > 1$) Allow B(30,0.95) or B(30, 0.5) for B1 30×0.05 alone insufficient for B1 " C_r insufficient for B1
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(i)	(b)	<p>Addition method: $X \sim B(30, 0.05)$ & $Y \sim B(15, 0.05)$ stated or implied</p> <p>$P(X = 2) = (0.8122 - 0.5535)$ or ${}^{30}C_2 \times 0.95^{28} \times 0.05^2$ or 0.2587/6 <u>OR</u> $P(Y \geq 1) = (1 - 0.95^{15})$ or 0.5367</p> <p>“0.2587/6” \times “0.5367” or 0.1388</p> <p>$P(X > 2) + P(X = 2) \times P(Y \geq 1)$ = “0.1878” + “0.1388” alone</p> <p>= 0.327 (3 sf) AG</p> <p>For A1 must see correct wking or 0.3265/6...</p>	<p>B1</p> <p>M1</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>[5]</p>	<p>NB eg 0.0362 implies B(15, 0.05) see below</p> <p>fully correct method for $P(X=2) \times P(Y \geq 1)$</p> <p>[their (a)+any p] alone, but dep 1st M1</p> <p>If ans 0.327, check whether it comes from a correct method (possibly not in MS) or clearly comes from an incorrect method eg $(0.4465 + 0.2587) \times 0.4633 = 0.327$ (ie $(P(X \geq 2) + P(X = 2)) \times P(Y = 0)$ B1M1M0M0A0</p>
(ii)		<p>Any use of 0.327 or their (i)(b) for 1st M1</p> <p>$(1 - 0.327)^3 \times 0.327 + (1 - 0.327)^4 \times 0.327$ Allow “correct” use of their (i)(a) or (i)(b) for 2nd M1</p> <p>= 0.167 (3 sf)</p>	<p>M1</p> <p>M1</p> <p>A1</p> <p>[3]</p>	<p>$(0.5535 + 0.2586 \times 0.4633)^3 \times 0.327 + (0.5535 + 0.2586 \times 0.4633)^4 \times 0.327$</p>

Q5 (Jun 2014, Q4) [Modified]

(i)	(a)	Binomial seen or implied $0.6228 - 0.3497$ $= 0.273$ (3 sf)	M1 M1 A1 [3]	by use of table or 9C_6 or $(\frac{2}{3})^p(\frac{1}{3})^q$ ($p + q = 9$) ${}^9C_6(\frac{1}{3})^3(\frac{2}{3})^6$ $\frac{1792}{6561}$
(i)	(b)	0.3497 or 0.350 (3 sf)	B1 [1]	NB 0.3498 (from 0.6228 - 0.273) rounds to 0.350 so B1
(ii)		27 seen $B(27, \frac{2}{3})$ seen or implied ${}^{27}C_{18}(\frac{1}{3})^9(\frac{2}{3})^{18}$ $= 0.161$ (3 sf)	B1 M1 M1 A1 [4]	not necessarily in a statement or attempt eg $P(X_1 = 1) \times P(X_2 = 8) \times P(X_3 = 9)$, $P(X_1 = 2) \times P(X_2 = 7) \times P(X_3 = 9)$, $P(X_1 = 3) \times P(X_2 = 6) \times P(X_3 = 9)$, etc ≥ 3 sets with $X_1 + X_2 + X_3 = 18$ (not nec'y added) M1

Q6 (Jun 2015, Q5) [Modified]

(ii)		Bin stated ${}^8C_2 \times (1 - 0.27)^6 \times 0.27^2$ 0.309 (3 sf)	B1 B1 B1 [3]	or implied by 8C_2 or 8C_6 or $(1 - 0.27)^a \times 0.27^b$ ($a + b = 8$) NOTE. Must see sub in formula for this B1
(iii)		Their (ii) $\times 0.27$ seen together Their (ii) $\times 0.27 \times (1 - 0.27)^2 \times 0.27$ ie wholly correct method fit(ii) $= 0.0120$ (3 sf)	M1 M1 A1ft [3]	or $({}^8C_2 \times (1 - 0.27)^6 \times 0.27^2) \times 0.27$ seen together or ${}^8C_2 \times (1 - 0.27)^6 \times 0.27^2 \times 0.27 \times (1 - 0.27)^2 \times 0.27$ ie wholly correct method Allow 0.012; fit their (ii) only

Q7 (Jun 2016, Q5) [Modified]

i	a	0.414(2)	B1 [1]	
i	b	0.4142 - 0.2677 $= 0.1465$ or 0.147 (3 sf) allow 0.146	M1 A1 [2]	${}^{25}C_{14} \times 0.4^{11} \times 0.6^{14}$
ii		${}^{24}C_y \times 0.7^{24-y} \times 0.3^y$ oe $({}^{24}C_8 \times 0.7^{16} \times 0.3^8 =)$ 0.160 (3 sf)	B1 B1 [2]	Allow other letters for y Allow 0.16
iii		$(0.8^2)^2 + (2 \times 0.8 \times 0.2)^2 + (0.2^2)^2$ oe $= \frac{321}{625}$ or 0.5136 or 0.514	M2 A1 [3]	or $0.64^2 + 0.32^2 + 0.04^2$ or $\frac{256}{625} + \frac{64}{625} + \frac{1}{625}$ oe

Q8 (Jun 2017, Q8)

i		$B(10, \frac{7}{8})$ or Binomial & $n = 10, p = \frac{7}{8}$ Arrival of each parcel is independent or Prob parcel arrives not affected by others or Prob parcel arrives is constant oe	B1 B1 [2]	or Binomial and $(10, \frac{7}{8})$ Allow: Parcels are independent Deliveries are independent Arrivals are independent P(parcel arrives) is independent Friends are indep	NB just 10 & $\frac{7}{8}$ seen: not enough In context Ignore all else The two B-marks are independent NOT No other factors involved
ii	a	0.263 (3 sf)	B1 [1]		
ii	b	$P(X = 9, 10)$ $= 10(\frac{1}{8})(\frac{7}{8})^9 + (\frac{7}{8})^{10}$ alone $= 0.639$ (3 sf)	M1 A1 [2]	all correct or (ii)(a) + $10(\frac{1}{8})(\frac{7}{8})^9$ cao	or $1 - P(X \leq 8)$ all terms correct or $1 - 0.361$ 0.639, no wking, M1A1 Use of tables: M0A0 0.64, no wking: M0A0
iii		Their "0.263" or $(\frac{7}{8})^{10}$ used $5 \times "0.263" \times (1 - "0.263") + "0.263"^{5}$ $= 0.0189$ (3 sf)	M1 M1 A1 [3]	or better cao	or $1 - (0.737^5 + \dots + {}^5C_3 \times 0.737^2 \times 0.263^3)$ all 4 terms correct ft their 0.263 If (ii)(b) used instead of (ii)(a), (must see working) allow M0M1A0