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-Σ: 1 term extra or omit or wrong: M1
(iii)	1 – "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 → (iii) 0.0178 from correct wking: M3A0 $0.0702^{20}+{}^{20}C_1 \times 0.9298 \times 0.0702^{19}$ ($=2.25\times10^{-21}$): 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
iia	${}^{15}C_4 \times (1-0.22)^{11} \times 0.22^4$ = 0.208 (3 sf)	M1 A1 2	Allow M1 for ${}^{15}C_4 \times 0.88^{11} \times 0.22^4$
iib	(15 × 0.22 =) 3.3 15×0.22×(1–0.22) or '3.3'×(1–0.22) = 2.57 (3 sf)	B1 M1 A1 3	Allow M1 for 15 × 0.22 × 0.88

Q3 (Jun 2011, Q3) [Modified]

3ia	$(1 - 0.5565)$ or $12\times0.85^{11}\times(1-0.85) + 0.85^{12}$	M1	or $1 - ((1-0.85)^{12} \ldots {}^{12}C_{10}\times0.85^{10}(1-0.85)^{2})$ ie 1 – (all 11 correct binomial terms)
	$= 0.4435$ or 0.443 or 0.444 (3 sf)	A1 2	
b	$0.5565 - 0.2642$ or ${}^{12}C_{10}(1-0.85)^{2}(0.85)^{10}$	M1	
	$= 0.2923$ or 0.2924 or 0.292 (3 sf)	A1 2	
c	$12 \times 0.85 \times (1-0.85)$	M1	
	$= 1.53$ oe	A1 2	
ii	$(\frac{3}{4})^2$ AND $\frac{3}{4}\times\frac{1}{4}$ seen (possibly × 2)	M1	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
	$(\frac{3}{4})^2 \times 2 \times \frac{3}{4}\times\frac{1}{4}$ oe or $\frac{27}{128}$ or 0.211	M1	or eg 0.5625×0.375
	$2 \times (\frac{3}{4})^2 \times 2 \times \frac{3}{4}\times\frac{1}{4}$ oe	M1	Fully correct method
	$= \frac{27}{64}$ or 0.422 (3 sfs)	A1 4	

Q4 (Jun 2013, Q7)

(i)	**(a)**	$X \sim B(30, 0.05)$ seen or implied	B1	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 ${}^{n}C_{r}$ insufficient for B1
		$P(X > 2) = 1 - 0.8122$ alone or $1-(0.95^{30}+30\times0.95^{29}\times0.05+{}^{30}C_{2}\times0.95^{28}\times0.05^{2})$	M1	
		$= 0.1878$ or 0.188 (3 sfs)	A1	
			[3]	

(i)	**(b)**	Addition method: X~B(30,0.05) & Y~B(15,0.05) stated or implied	B1	NB eg 0.0362 implies B(15, 0.05) see below
		$P(X = 2) = (0.8122–0.5535)$ or ${}^{30}C_2 \times 0.95^{28} \times 0.05^2$ or 0.2587/6 OR $P(Y \geq 1) = (1 – 0.95^{15})$ or 0.5367	M1	
		"0.2587/6" × "0.5367" or 0.1388	M1	fully correct method for $P(X=2) \times P(Y \geq 1)$
		$P(X > 2) + P(X = 2) \times P(Y \geq 1)$ = "0.1878" + "0.1388" alone	M1	[their (a)+any p] alone, but dep 1st M1
		= 0. 327 (3 sf) **AG** For A1 must see correct wking or 0.3265/6...	A1	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
			[5]	
(ii)		Any use of 0.327 or their **(i)(b)** for 1st M1	M1	
		$(1 – 0.327)^3 \times 0.327 + (1 – 0.327)^4 \times 0.327$ Allow "correct" use of their **(i)(a)** or **(i)(b)** for 2nd M1	M1	$(0.5535 + 0.2586 \times 0.4633)^3 \times 0.327 + (0.5535 + 0.2586 \times 0.4633)^4 \times 0.327$
		= 0.167 (3 sf)	A1	
			[3]	

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 $\geq$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) × 0.27 seen together Their (ii) × $0.27\times(1-0.27)^2\times 0.27$ ie wholly correct method ft(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; ft 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 & $n = 10$, $p = \frac{7}{8}$	**B1**	or Binomial and (10, $\frac{7}{8}$)	NB just 10 & $\frac{7}{8}$ seen: not enough
		Arrival of each parcel is independent or Prob parcel arrives not affected by others or Prob parcel arrives is constant oe	**B1** **[2]**	Allow: Parcels are independent Deliveries are independent Arrivals are independent P(parcel arrives) is independent Friends are indep	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 ≤ 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"$^4 \times$(1 - "0.263") + "0.263"^{5} = 0.0189 (3 sf)	**M1** **M1** **A1** **[3]**	or better cao	 or $1–(0.737^5+...+ {}^5C_3 \times 0.737^2 \times 0.263^3)$ all 4 terms correct ft their 0.263 If (ii)(b) used instead of (ii)(a), (must see working) allow M0M1A0