Binomial Distribution (From OCR 4732)

Q1, (Jan 2007, Q4)

ia	**W & Y** *oe*	B1 1	
b	**X** *oe*	B1 1	
ii	Geo probs always decrease or Geo has no upper limit to x or $x \neq 0$	B1 1	Geo not fixed no. of values diags have fixed no of trials not Geo has +ve skew
iii	**W** Bin probs cannot fall then rise or bimodal	B1 B1dep 2	indep allow Bin probs rise then fall
Total		**5**	

Q2, (Jan 2007, Q9)

i	${}^{11}C_5 \times (1/4)^6 \times (3/4)^5$ 0.0268 (3 sfs)	M1 A1 2	or $462 \times (1/4)^6 \times (3/4)^5$
ii	$q^{11} = 0.05$ or $(1-p)^{11} = 0.05$ $\sqrt[11]{0.05}$ $q = 0.762$ or 0.7616 . . . $p = 0.238$ (3 sfs)	M1 M1 A1 A1f 4	(any letter except p)$^{11} = 0.05$ oe oe or invlog$(\frac{\log 0.05}{11})$ ft dep M2
iii	$11 \times p \times (1-p) = 1.76$ oe $11p - 11p^2 = 1.76$ or $p - p^2 = 0.16$ $11p^2 - 11p + 1.76 = 0$ or $p^2 - p + 0.16 = 0$ $(25p^2 - 25p + 4 = 0)$ $(5p-1)(5p-4) = 0$ or $p = \frac{11 - \sqrt{(11^2 - 4 \times 11 \times 1.76)}}{2 \times 11}$ $p = 0.2$ or 0.8	M1 A1 A1 M1 A1 5	not $11pq = 1.76$ any correct equn after mult out or equiv with = 0 or correct fact'n or subst'n for their quad equ'n eg $p = \frac{1 \pm \sqrt{(1-4 \times 0.16)}}{2}$
Total		**11**	

Q3, (Jun 2008, Q3)

(i)(a)	0.9368 or 0.937	B1 1	
(b)	$0.7799 - 0.5230$ or ${}^8C_5 \times 0.45^3 \times 0.55^5$ $= 0.2569$ or 0.2568 or 0.257	M1 A1 2	Allow $0.9368 - 0.7799$
(c)	0.7799 seen $-$ 0.0885 (not $1 - 0.0885$) $= 0.691$ (3 sfs)	M1 M1 A1 3	${}^8C_5 \times 0.45^3 \times 0.55^5 + {}^8C_4 \times 0.45^4 \times 0.55^4 + {}^8C_3 \times 0.45^5 \times 0.55^3$: M2 1 term omitted or wrong or extra: M1
(ii)(a)	${}^{10}C_2 \times (7/12)^8 \times (5/12)^2$ seen $= 0.105$ (3 sfs)	M1 A1 2	or 0.105 seen, but not ISW for A1
(b)	$2^{31}/_{72}$ or $^{175}/_{72}$ or 2.43 (3 sfs)	B1 1	NB $^{12}/_5 = 2.4$: B0
Total		**9**	

Q4, (Jun 2009, Q1)

			Q1: if consistent "0.8" incorrect or $^1/_8$, $^7/_8$ or 0.02 allow M marks in ii , iii & 1st M1 in i
i	Binomial stated $0.9437 - 0.7969$ or $^8C_3 \times 0.2^3 \times 0.8^5$ $= 0.147$ (3 sfs)	M1 M1 A1 3	or implied by use of tables or $^8C_3$ or $0.2^a \times 0.8^b$ $(a+b = 8)$
ii	$1 - 0.7969$ $= 0.203$ (3 sf)	M1 A1 2	allow $1 - 0.9437$ or 0.056(3) or equiv using formula
iii	8×0.2 oe 1.6	M1 A1 2	$8 \times 0.2 = 2$ M1A0 $1.6 \div 8$ or $^1/_{1.6}$ M0A0
Total		**7**	

Q5, (Jun 2011, Q3)

ia	$(1 - 0.5565)$ or $12\times0.85^{11}\times(1-0.85) + 0.85^{12}$	M1	or $1 - ((1\text{-}0.85)^{12}\ldots{}^{12}C_{10}\times0.85^{10}(1\text{-}0.85)^{2})$ ie $1 -$ (all 11 correct binomial terms)	or $1 - 0.557$
	$= 0.4435$ or 0.443 or 0.444 (3 sf)	A1 2		NB $1 - 0.4435$ (oe): M0A0
b	$0.5565 - 0.2642$ or ${}^{12}C_{10}(1-0.85)^{2}(0.85)^{10}$	M1		or $0.557 - 0.264$
	$= 0.2923$ 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 $\times 2$)	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 $0.5625 + 0.375$	or $\frac{9}{16}$ and $\frac{3}{16}$ or $\frac{9}{16}$ and $\frac{3}{8}$ eg in table or list
	$(\frac{3}{4})^2 \times 2 \times \frac{3}{4}\times\frac{1}{4}$ oe or $\frac{27}{128}$ or 0.211	M1	or eg 0.5625×0.375	Allow even if further incorrect wking
	$2 \times (\frac{3}{4})^2 \times 2 \times \frac{3}{4}\times\frac{1}{4}$ oe	M1	Fully correct method	
	$= \frac{27}{64}$ or 0.422 (3 sfs)	A1 4		Ans 0.211: check wking but probably gets M1M1M0A0
				Use of 0.85 instead of $\frac{1}{4}$: MR max M1M1M1A0
Total		**10**		

Q6, (Jan 2013, Q5)

		If incorrect p used consistently in all parts of qu 5, no mks in **(i)(a)** & **(b)** but can score M–marks in **(ii)** and **(iii)**.			
(i)	**(a)**	1.25 oe	B1 **[1]**		
(i)	**(b)**	0.8965 – 0.6328 = 0.264 (3 sf)	M1 A1 **[2]**	${}^5C_2(\frac{3}{4})^3(\frac{1}{4})^2$ $= \frac{135}{512}$ or 0.264 (3 sf)	 Answer which rounds to 0.264
(ii)		Answer which rounds to 0.244	M1 M1 M1 A1 **[4]**	$((\frac{3}{4})^5)^2$ or $(\frac{243}{1024})^2$ or $(\frac{3}{4})^{10}$ oe $(= \frac{59049}{1048576})$ $(\frac{3}{4})^5 \times 5(\frac{3}{4})^4(\frac{1}{4})$ or $\frac{243}{1024} \times \frac{405}{1024}$ or $5(\frac{3}{4})^9(\frac{1}{4})$ $(= \frac{98415}{1048576})$ 2×(attempt P(1, 0) alone), (NOT 2×(P(1,0) + P(0,0)) If P(sum ≤ 2), all three M-mks are available, but for 3rd M1, must be 2×(P(1,0)+P(2,0)) only Ans 0.150 probably M1M1M0A0 but check working Ans 0.188 probably M0M1M1A0 but check working	B(10. 0.25) seen or implied M1 Table or formula with $n = 10$ used M1 P($X \leq 1$) from table or $(\frac{3}{4})^{10} + 10(\frac{3}{4})^9 \times (\frac{1}{4})$ M1 0.244 (3 sf) A1 P($X \leq 2$) = 0.526 from table $n = 10$ M1M1M1A0 SC P($X = 2$) answer 0.282: B1
(iii)		Use of 0.2637 or 0.264 ${}^{10}C_3 \times (1 - \text{'0.2637'})^7 \times \text{'0.2637'}^3$ = 0.258 (3 sf)	M1 M1 A1 **[3]**	or their **(i)(b)** ft **(i)(b)** allow ft their **(ii)** for this M1 only Correct ans, no working: M1M1A1	SC allow ${}^{10}C_3 \times (1 - \text{'0.282'})^7 \times \text{'0.282'}^3$ M0M1 (0.282 comes from P(3 totals = 2))