OCR Maths S1

Topic Questions from Papers

Binomial and Geometric Distributions

Answers

1	(i)	(a)	Geo(0.05) $(19/20)^5(1/20)$ = 0.0387	M1 M1 A1 3	Geo(0.05) or 0.95 stated or implied q^5p attempted Answer, a.r.t. 0.0387 ISW
		(b)	$(19/20)^{10}$ = 0.599	M1 M1 A1 3	q^{10} or $1 - p - pq \ldots - pq^9$ [q^9 or q^{11}, or one wrong term: M1M0] Answer, a.r.t. 0.599 $1 - (^{19}/_{20})^{10}$: M0M0A0
	(ii)		Mean = $1/p$ = 20	M1 A1 2	 20, cao

(Q5, Jan 2005)

2	(i)		Boxes are independent Probability same for each box	B1 B1 2	Both must be in context
	(ii)	(a)	B(8, 0.1) 0.4305	M1 A1	B(8, 0.1) stated or 0.1, 0.9 seen and sum of powers =8 0.43[05] correct
		(b)	$1 - P(\leq 1)$ 0.1869	M1 A1 4	$1 - 0.8131$ or $1 - (0.9^8 + 8x0.9^7x\ 0.1)$ correct Answer, a.r.t. 0.187
	(iii)		$2 \times 0.4305 \times 0.1869$ 0.16092	M1 M1 A1 3	(a) x (b) } 2 x (a) × (b) } Answer, a.r.t. 0.161

(Q7, Jan 2005)

3 (i) (a) Geo(0.14) stated in (a) or (b) $(0.86)^4$ x 0.14 = 0.0766 (3 sfs)	B1 M1 A1 3	or 0.86^nx0.14 or 0.14^nx0.86 in (a) or ≥ M1 in (b) or Geo(0.86) stated in (a) or (b) No wking: 0.077: B1M1A0
(b) $1 - 0.86^7$ or 0.14 + 0.86x0.14…+ 0.86^6x0.14 = 0.652 (3 sfs)	M2 A1 3	$1 - 0.86^8$: M1 +8th term (r = 7 or 0) or 1 missing term: M1
(ii) 1/0.14 = $^{50}/_7$ or 7.14 (3 sfs)	M1 A1 2	
	8	

(Q2, June 2005)

4 (i) (a) B(16, 0.35) stated	B1		Or implied by use of tables or 0.35^{a}x0.65^{b} (a+b = 16) in (a) or (b)
1 – 0.8406	M1		Allow 1 – 0.9329 or 0.0671 Or complete method using formula, P(r = 8-16 or 9-16) or 1-P(r = 0-7 or 0-8)
= 0.159 (3 sfs)	A1	3	
(b) 0.9771 – 0.1339	M1		Allow 0.9771 – 0.2892 Or complete method using formula (r = 4-9)
= 0.843 (3 sfs)	A1	2	
(ii) $^{16}C_6(0.38)^6(0.62)^{10}$	M2		Absent or incorr coeff : M1 or $^{16}C_6(0.38)^{10}(0.62)^6$: M1
= 0.202 (3 sfs)	A1	3	
	8		

(Q3, June 2005)

5 (i)	0.4207 or 0.421 (3 sfs) or $0.8^{25}+25x0.8^{24}x0.2$ + .. $^{25}C_4x0.4^{21}x0.2^4$ 0.579(3)	B1 B1	**2**	or 1 – 0.6167 or 0.3833 (3 sfs) or 1- (6 correct terms, 0 to 5)
(ii)	$^{10}C_3$ x $(1-0.27)^7$ x 0.27^3 = 0.261 (3 sfs)	M1 A1	**2**	
(iii)	$0.73^9 = 0.059$ $0.73^{10} = 0.043$ $n = 10$	Allow "=" thro'out $1 - 0.73^n > 0.95$ or $0.73^n < 0.05$ $n$log0.73 < log0.05 oe	M1 M1 A1	**3**	or 1 - $^nC_0$ x 0.27^0 x $0.73^n > 0.95$ oe allow incorrect sign M1 must be correct ft (1 – 0.27) from (ii) for M1M1 10 with incorrect sign in wking: SCB2 10 with just $0.73^9 = 0.059$: M1M1A1
Total		**7**		

(Q4, June 2006)

6 (i)	Geometric. Each attempt (or result or try) indep	B1 B1 **2**	In context. Not "events,. trials, outcomes" . Ignore extra
(ii)(a)	$(^2/_3)^3 \times {}^1/_3$ $= {}^8/_{81}$ or 0.0988 (3 sfs)	M2 A1 **3**	$(^2/_3)^2 x^1/_3$ or $(^2/_3)^4 \times {}^1/_3$: allow other numerical "p" ($0<p<1$):M1
(b)	$(^2/_3)^3$ $1 - (^2/_3)^3$ $= {}^{19}/_{27}$ or 0.704 (3sfs)	M1 M1 A1 **3**	not $(^2/_3)^3 \times \ldots$. or $^1/_3 + {}^2/_3 x^1/_3 + (^2/_3)^2 x^1/_3$ M2 $1 - (^2/_3)^4$ or $1 - (\text{"}q\text{"})^4$ M1 or 3 terms, with 2 correct M1 or 3 correct terms + 1 extra M1 or "p" + "qp" + "q^2p" M1 or 1 – sum of 3 correct terms M1 "p" means num value, not $^1/_3$
(iii)	3	B1f **1**	or $^1/_{\text{"}p\text{"}}$
(iv)	$1 - {}^{19}/_{27}$ | (1 – 0.7037) or 0.2963 $(^8/_{27})^2 \times {}^{19}/_{27}$ | $0.2963^2 \times 0.7037$ $= {}^{1216}/_{19683}$ | = 0.0618 (3 sfs)	M1 M1 A1 **3**	ft (b) for M1M1 must see method if ft Allow figs rounded to 2 sfs for M1M1 cao. allow art 0.0618 or 0.0617
Total		**12**	

(Q8, June 2006)

7 (i)	Geo($^2/_3$) stated $(^1/_3)^3 \times {}^2/_3$ $= {}^2/_{81}$ or 0.0247 (3 sfs)	M1 M1 A1 3	or implied by $(^1/_3)^n \times {}^2/_3$
ii	$(^1/_3)^3$ $1 - (^1/_3)^3$ $^{26}/_{27}$ or 0.963 (3 sfs)	M1 M1 A1 3	or $^2/_3 + {}^1/_3 x^2/_3 + (^1/_3)^2 x^2/_3$: M2 one term omitted or extra or wrong: M1 $1 - (^1/_3)^4$ or $1 - (^2/_3 + {}^1/_3 x^2/_3 + (^1/_3)^2 x^2/_3)$:M1
iii	1 / 2/3 = 3/2 oe	M1 A1 2	
Total		**8**	

(Q6, Jan 2007)

8 (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**	

(Q9, Jan 2007)

9 (i)	P(contains voucher) constant oe Packets indep oe	B1 B1 2	Context essential NOT vouchers indep
ii	0.9857 or 0.986 (3 sfs)	B2 2	B1 for 0.9456 or 0.946 or 0.997(2) or for 7 terms correct, allow one omit or extra NOT 1 – 0.9857 = 0.0143 (see (iii))
iii	(1 – 0.9857) = 0.014(3) (2 sfs)	 B1ft 1	 Allow 1- their (ii) correctly calc'd
iv	B(11, 0.25) or 6 in 11 wks stated or impl $^{11}C_6 \times 075^5 \times 0.25^6$ (= 0.0267663) P(6 from 11) × 0.25 = 0.00669 or 6.69×10^{-3} (3 sfs)	B1 M1 M1 A1 4	or $0.75^a \times 0.25^b$ ($a + b = 11$) or $^{11}C_6$ dep B1
Total		**9**	

(Q7, June 2007)

10 (ia)	$1 / {}^1/_5$ $= 5$	M1 A1 2	
b	$({}^4/_5)^3 \times {}^1/_5$ $= {}^{64}/_{625}$ or 0.102 (3 sfs)	M1 A1 2	
c	$({}^4/_5)^4$ $= {}^{256}/_{625}$ or a.r.t 0.410 (3 sfs) or 0.41	M1 A1 2	or 1- $({}^1/_5 + {}^4/_5 \times {}^1/_5 + ({}^4/_5)^2 \times {}^1/_5 + ({}^4/_5)^3 \times {}^1/_5)$ NOT 1 - $({}^4/_5)^4$
iia	P(Y=1) = p, P(Y=3) = q^2p, P(Y=5) = q^4p	B1 1	P(Y =1)+P(Y =3)+P(Y =5)= $p + q^2p + q^4p$ p, $p(1 - p)^2$, $p(1 - p)^4$ q^{1-1}, q^{3-1}, q^{5-1} or any of these with $1 - p$ instead of q "Always q to even power × p" Either associate each term with relevant prob Or give indication of how terms derived ≥ two terms
b	Recog that c.r. = q^2 or $(1 - p)^2$ $S_\infty = \frac{p}{1-q^2}$ or $\frac{p}{1-(1-p)^2}$ P(odd) = $\frac{1-q}{1-q^2}$ $= \frac{1-q}{(1-q)(1+q)}$ Must see this step for A1 $(= \frac{1}{1+q}$ **AG**)	M1 M1 M1 A1 4	or eg $r = q^2p/p$ $(= \frac{p}{2p-p^2}) = \frac{p}{p(2-p)}$ $(= \frac{1}{2-p}) \frac{1}{2-(1-q)}$

(Q9, June 2007)

11 (i)	$({}^4/_5)^3 \times ({}^1/_5)$ oe $= {}^{64}/_{625}$ or 0.102 (3 sfs)	M1 A1 2	Allow M1 for $({}^4/_5)^4$ x $({}^1/_5)$
ii	$({}^4/_5)^4$ alone or 1– $({}^1/_5 + {}^4/_5 x\, {}^1/_5 + ({}^4/_5)^2 x\, {}^1/_5 + ({}^4/_5)^3 x\, {}^1/_5)$ $= {}^{256}/_{625}$ or 0.410 (3 sfs)	M1 A1 2	Allow $({}^4/_5)^3$ or $({}^4/_5)^5$; not 1 - $({}^4/_5)^4$ Allow one term omitted or wrong or "correct" extra Allow 0.41
iii	5	B1 1	
Total		**5**	

(Q2, Jan 2008)

12 (ia)	Binomial stated or implied 0.9806	B1 B1 2	by use of tables or $0.2^a \times 0.8^b$, $a+b = 12$
b	0.5583 seen 1 – 0.5583 = 0.442 (3 sfs)	M1 M1 A1 3	add 10 corr terms or 1-(add 3 corr terms): M2 or 1– 0.7946 or 0.205 or 1-0.6774 or 0.323 or 1-0.3907 or 0.609 or add 9 terms or 1-(add 2 or 4 terms): M1
ii	$^{15}C_4 \times 0.3^4 \times 0.7^{11}$ = 0.219 (3 sfs)	M2 A1 3	$^{15}C_4 \times 0.3^{11} \times 0.7^4$: M1
Total		**8**	

(Q5, Jan 2008)

13 (ia)	Results or matches are indep Prob of winning is constant	B1 B1 2	allow "wins" indep; not "trials" indep not "success"
ib	No of wins (or losses)	B1 1	
ii	$^{21}C_{10}p^{10}q^{11} = {}^{21}C_9 p^9 q^{12}$ $\frac{12}{10} p = q$ or $\frac{12}{10}p(1-p)^{-1} = 1$ or similar $1.2p = 1 - p$ oe eg $p = 0.833(1-p)$ or $352716p = 293930(1-p)$ $p = {}^5/_{11}$ or 0.455 (3 sfs) oe	 M1 M1M1 M1 A1 5	or $(1 - p)$ for q & allow omit bracket or $352716\,p^{10}q^{11} = 293930\,p^9q^{12}$ M1 for ${}^{12}/_{10}$ or ${}^6/_5$ or 1.2 or ${}^5/_6$ or 0.833 M1 for p & q cancelled correctly or equiv equn in p or q (cancelled) nos not nec'y cancelled; not alg denom
Total		**8**	

(Q7, Jan 2008)

14 (ia)	Geo stated $({}^7/_8)^2({}^1/_8)$ ${}^{49}/_{512}$ or 0.0957 (3 sfs)	M1 M1 A1 3	or impl. by $({}^7/_8)^n({}^1/_8)$ or $({}^1/_8)^n({}^7/_8)$ alone
(b)	$({}^7/_8)^3$ alone ${}^{343}/_{512}$ or 0.670 (3 sfs) allow 0.67	M2 A1 3	or $1-({}^1/_8+{}^7/_{8\times}{}^1/_8+({}^7/_8)^2\times{}^1/_8)$: M2 one term incorrect, omit or extra: M1 $1 - ({}^7/_8)^3$ or $({}^7/_8)^2$ alone: M1
(ii)	8	B1 1	
(iii)	Binomial stated or implied $^{15}C_2({}^7/_8)^{13}({}^1/_8)^2$ = 0.289 (3 sfs)	M1 M1 A1 3	eg by $({}^7/_8)^a({}^1/_8)^b$ ($a+b = 15$, $a,b \neq 1$), not just ^nC_r
Total		**10**	

(Q3, Jan 2009)

15 (i)	Binomial $n = 12$, $p = 0.1$ Plates (or seconds) independent oe Prob of fault same for each plate oe	B1 B1 B1 B1 4	 B(12, 0.1) : B2 NOT: batches indep Comments must be in context Ignore incorrect or irrelevant
(ii)(a)	$0.9744 - 0.8891$ or ${}^{12}C_3 \times 0.9^9 \times 0.1^3$ $= 0.0852$ or 0.0853 (3 sfs)	M1 A1 2	
(b)	$1 - 0.2824$ or $1 - 0.9^{12}$ $=0.718$ (3 sfs)	M1 A1 2	allow $1 - 0.6590$ or $1 - 0.9^{11}$
(iii)	"0.718" and 1 – "0.718" used $(1-0.718)^4 + 4(1-0.718)^3 \times 0.718$ $+ {}^4C_2(1-0.718)^2 \times 0.718^2$ = 0.317 (3 sfs)	B1 M2 A1 4	ft (b) for B1M1M1 M1 for any one term correct (eg opp tail or no coeffs) 1 – P(3 or 4) follow similar scheme M2 or M1 1 – correct wking (= 0.623) B1M2 cao
Total		**12**	

(Q7, Jan 2009)

16			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**	

(Q1, June 2009)

17			Q4: if consistent "0.7" incorrect or $^1/_3$, $^2/_3$ or 0.03 allow M marks in ii , iii & 1st M1 in i
i	Geo stated $0.7^3 \times 0.3$ alone $^{1029}/_{10000}$ or 0.103 (3 sf)	M1 M1 A1 3	or implied by $q^n \times p$ alone ($n > 1$) $0.7^3 - 0.7^4$
ii	0.7^4 alone $= {}^{2401}/_{10000}$ or 0.240 (3 sf)	M1 A1 2	$1 - (0.3 + 0.7\times0.3 + 0.7^2\times0.3 + 0.7^3\times0.3)$ NB $1 - 0.7^4$: M0
iii	$1 - 0.7^5$ = 0.832 (3 sfs)	M2 A1 3	or $0.3 + 0.7\times0.3 + + \ldots. + 0.7^4\times0.3$ M2 M1 for one term extra or omitted or wrong or for 1– (above) M1 for $1 - 0.7^6$ or 0.7^5 NB Beware: $1 - 0.7^6 = 0.882$
		8	

(Q4, June 2009)

18 (i)	$(1 - 0.12)^n$ $\underline{\log 0.05}$ $\log 0.88$ $n = 24$	 or $0.88^{23} = 0.052...$ or $0.88^{24} = 0.046...$ 	M1 M1 A1 3	Can be implied by 2nd M1 allow $n - 1$ or $\log_{0.88}0.05$ or 23.4(…) Ignore incorrect inequ or equals signs
ii	${}^6C_2 \times 0.88^4 \times 0.12^2$ $\times 0.12$ $= 0.0155$	(= 0.1295…)	M3 M1 A1 5	or $0.88^4 \times 0.12^2$ M2 or ${}^6C_2 \times 0.88^4 \times 0.12^2$ + extra M2 or 2 successes in 6 trials implied or ${}^6C_2$ M1 dep $\geq$ M1 $0.88^4\times0.12^2\times0.12$: M2M1 $0.88^4 \times 0.12^3$ M0M0A0 unless clear P(2 success in 6 trials) $\times$ 0.12 in which case M2M1A0
Total			**8**	

(Q9, June 2009)

19 (i)	attempts at threading indep prob of succeeding in threading const	B1 B1 2	in context in context
(ii) (a)	$0.7^4 \times 0.3$ = 0.0720 (3sf)	M1 A1 2	 Condone 0.072
(b)	0.7^5 = 0.168 (3 sfs)	M2 A1 3	or 1-(0.3+0.7×0.3+0.7^2×0.3+0.7^3×0.3 +0.7^4×0.3) M1 for one term omitted or extra or wrong or 1-0.7^5 or(0.3+...+0.7^4×0.3) or 0.3, 0.7 muddle or 0.7^4 or 0.7^6 alone. 0.6 not 0.7 M0 in **(a)** M1 in **(b)** 1/3,2/3 used M1in **(a)** M1 in **(b)**
(iii)	likely to improve with practice hence independence unlikely or prob will increase each time	B1 B1 2	or thread strands gradually separate 1st B1 must be in context. hence independence unlikely or prob will decrease each time or similar Allow 'change'
Total		**[9]**	

(Q1, Jan 2010)

20 (i)	p^2	B1 1	
(ii)	$(q^2p)^2$ oe =AG	B1 1	
(iii)	r=q^2 a/(1-r) used $(S_\infty =)\ \frac{p^2}{1-q^2}$ $= \frac{p^2}{1-(1-p)^2}$ p/(2-p) AG	B1 M1 A1 M1 A1 5	May be implied With $a=p^2$and $r=q^2$or q^4 Attempt to simplify using p+q=1 correctly. Dep on $r = q^2$ or q^4 $\frac{(1-q)^2}{(1-q)(1+q)}$ or $p^2/p(1+q)$ Correctly obtain given answer showing at least one intermediate step.
P2Total		**[7]**	

(Q9, Jan 2010)

21 (ia)	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	$^{15}C_4$×$(1\text{-}0.22)^{11}$×0.22^4 = 0.208 (3 sf)	M1 A1 2	Allow M1 for $^{15}C_4$×0.88^{11}×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
Total		**8**	

(Q4, June 2010)

22 (ia)	Geo(0.3) stated or implied $0.7^3 \times 0.3$ = 0.103 (3 sf)	M1 M1 A1 3	by $0.7^n \times 0.3$
b	0.7^3 or 0.343 $1 - 0.7^3$ = 0.657	M1 M1 A1 3	0.7^3 must be alone, ie not $0.7^3 \times 0.3$ or similar allow $1 - 0.7^4$ or 0.7599 or 0.76 for M1 only or $0.3 + 0.7\times0.3 + 0.7^2\times0.3$: M1M1 1 term wrong or omitted or extra M1 or $1 - (0.3 + 0.7\times0.3 + 0.7^2\times0.3)$ or 0.343: M1
iia	State or imply one viewer in 1st four ${}^4C_1 \times 0.7^3 \times 0.3$ (= 0.412) $\times 0.3$ = 0.123 (3 sf)	M1 M1 M1 A1 4	or B(4, 0.3) stated, or ${}^4C_1$ used, or YNNNY dep 1st M1
b	$0.7^5 + {}^5C_1 \times 0.7^4 \times 0.3$ = 0.528 (3 sf)	M1 A1 2	or $1-(0.3^2 + 2\times0.3^2\times0.7 + 3\times0.3^2\times0.7^2 + 4\times0.3^2\times0.7)$ Not ISW, eg 1 – 0.528: M1A0
Total		**12**	

(Q8, June 2010)

23				SC:Consistent use of incorrect (1 – 0.2) score M-marks only SC:Consistent 0.8 insted of 0.2, no A-marks: max M0M2M2M2 "Consistent" means in every part attempted
i	$0.8^2\times0.2$ = $\frac{16}{125}$ or 0.128	M1 A1 2		
ii	$0.8^2\times0.2 + 0.8^3\times0.2 + 0.8^4\times0.2$ = $\frac{976}{3125}$ or 0.312 (3 sfs)	M2 A1 3	1 term omitted or wrong or extra: M1	Using $P(X\leq5)$ & $P(X\leq2)$; three methods: $1 - 0.8^5 - (1-0.8^2)$ or 0.672 – 0.36: M2 Allow M1 for $1 - 0.8^5 - (1-0.8^3)$ or 0.672 – 0.488 or $1 - 0.8^4 - (1-0.8^2)$ or 0.5904 – 0.36 $0.8^2 - 0.8^5$: M2 Allow M1 for $0.8^3 - 0.8^5$ or $0.8^2 - 0.8^4$ $0.2+0.8\times0.2+0.8^2\times0.2+0.8^3\times0.2+0.8^4\times0.2 - (0.2+0.8\times0.2)$: M2 One term omitted or wrong or extra: M1 But NB If include $0.8^{-1}\times0.2$ in both $P(X\leq5)$ & $P(X\leq2)$, get correct ans but M1M0A0 M0 for eg $1 - 0.8^5 - 0.8^2$ or 0.672 – 0.64
iii	0.8^4 = $\frac{256}{625}$ or 0.4096 or 0.410 (3 sfs)	M2 A1 3	1-(0.2 + 0.8×0.2 + $0.8^2\times0.2 + 0.8^3\times0.2$) 1 term omitted or wrong or extra: M1 $1 - 0.8^4$ or 0.590 M1 or 0.8^3 or 0.512 or 0.8^5 or 0.328: M1 Allow 0.41	$1 - (0.2 + 0.8\times0.2 + 0.8^2\times0.2 + 0.8^3\times0.2)$ M2 0.2×0.8^4 M0 $1 - 0.8^n$ $(n \neq 4)$ M0
iv	$0.2 \times 0.8 \times 0.2$ $\times 2$ = 0.064 or $^8/_{125}$	M1 M1 A1 3	or $0.2 \times 0.8^0 \times 0.8 \times 0.2$ or $0.2 \times 0.8 \times 0.2 + 0.8 \times 0.2 \times 0.2$	or 0.032 NOT $n \times 0.2^2 \times 0.8$ except $n = 2$ Fully correct method except allow M0M1 for $(0.2+0.8\times0.2) \times 2$, must see method Attempt 0,3 and/or 3,0, as well as 2,1and/or 1,2; max M1M0A0 Careful: $0.2\times0.8\times0.2+0.2\times0.8^{-1}\times0.128 = 0.064$ M1M0A0 Careful: $0.8\times0.8\times0.2 \div 2 = 0.064$: (ie $P(X = 3) \div 2$) M0M0A0
Total		**11**		

(Q2, Jan 2011)

24			Consistent use of $\frac{1}{3}$ or MR of 30% (eg 0.2): ("Consistent" as in Qu 2) (i) B1B0B1B1 (iia) B0 (iib) 0.7901–0.4609 or ${}^5C_2(\frac{2}{3})^3(\frac{1}{3})^2$ M1; = 0.329 (3 sf) A1 (iii) p = "0.3292" M1; ${}^7C_3(1 - \text{"0.3292"})^4(\text{"0.3292"})^3$ M1; = 0.253 (3 sf) A1 ie max 8/10	
i	Binomial or B (5, 0.3) Prob of gift same for all pkts Whether pkt contains gift is indep of other pkts	B1 B1 B1 B1 4	 Prob of gift is constant or fixed or consistent or same oe Obtaining a gift is indep Each time receive a gift is indep Context needed for 3rd & 4th B-mks	Allow mis-spellings but NOT "Biometric" Condone B~(5, 0.3) or B(0.3, 5): B1B1 but B(X = 0.3, n = 5): B1B0 NOT: prob of success const; NOT prob stays same each go One box doesn't affect another. Pkts indep. Gifts indep She buys packets separately Prob of a gift is indep Prob of gift indep of one another & const: B1B1 NOT: Each week is indep NOT: Number of gifts received is indep NOT: Events indep If Geo(0.3) stated, can score max B0B0B1B1 If Geo(5, 0.3) stated, can score max B0B1B1B1
iia	0.8369	B1 1	or 0.837	
b	0.8369 – 0.5282 or ${}^5C_2(0.7)^3(0.3)^2$ = 0.3087 or 0.309 (3 sf)	M1 A1 2		
iii	p = "0.3087" ${}^7C_3(1 - \text{"0.3087"})^4(\text{"0.3087"})^3$ = 0.235 (3 sf)	M1 M1 A1 3	(iib) used in a calc'n eg "0.3087" × 3	or B(7, "0.3087") stated or 1 – "0.3087" used instead of "0.3087" n = 35 or 15: max M1M0A0
Total		**10**		

(Q5, Jan 2011)

25 (ia)	(1 – 0.5565) or $12\times0.85^{11}\times(1–0.85) +0.85^{12}$ = 0.4435 or 0.443 or 0.444 (3 sf)	M1 A1 2	or 1 – $((1\text{-}0.85)^{12}$…. ${}^{12}C_{10}\times0.85^{10}(1\text{-}0.85)^2)$ ie 1 – (all 11 correct binomial terms)	or 1 – 0.557 NB 1 – 0.4435 (oe): M0A0
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		or 0.557 – 0.264
c	12 × 0.85 × (1–0.85) = 1.53 oe	M1 A1 2		
ii	$(\frac{3}{4})^2$ AND $\frac{3}{4}\times\frac{1}{4}$ seen (possibly × 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 × 0.375 Fully correct method	or $\frac{9}{16}$ and $\frac{3}{16}$ or $\frac{9}{16}$ and $\frac{3}{8}$ eg in table or list Allow even if further incorrect wking Ans 0.211: check wking but probably gets M1M1M0A0 Use of 0.85 instead of $\frac{1}{4}$: MR max M1M1M1A0
Total		**10**		

(Q3, June 2011)

26	(i)		$(1 - 0.12)^{13}$ or $13\times(1 - 0.12)^{12}\times0.12$ $(1 - 0.12)^{13} + 13\times(1 - 0.12)^{12}\times0.12$ = 0.526 (3 sf)	M1 M1 A1[3]	Either seen Fully correct method	1 – correct terms: M1M0A0
	(ii)		$^{13}C_2\times0.12^2\times(1 - 0.12)^{11}$ 2 × "0.275275" × (1 – "0.275275") = 0.399 (3 sf)	M1 M1 A1 [3]	or 0.275(…) Correct method except allow omit "2 ×"	Allow if × or + something NB unlike 2nd M1 in (i) which is for fully correct method NB 2 × 0.12 × 0.88: M0M0A0

(Q3, Jan 2012)

27	(i)		V because [probs or values or geometric or etc] decreasing or halving or Highest prob is 1st Allow if word "decreasing" or "halving" or "sloping downwards" or any equivalent seen NOT "Positive skew"	B1 B1 [2]	*X* because mode = 1 oe or Highest prob is P(1) oe B2 *Z* because P(0) = 0 or variable can't be 0 oe Allow "Geo distr'n cannot be zero" oe B2 "None of them": Ignore any reason given. B2	For answer V the first B1 is indep, but not for other answers, ie: V with no reason or incorrect reason scores B1B0, but Z or X or any other letter with no reason or incorrect reason scores B0B0. In all cases, once mark(s) have been scored, ignore all other comments.
	(ii)		Y. Peaks at 2 Y. Like normal, peak at 2 Y. Highest prob is middle one (or is at 2) Y. P(X = 2) is max Y. Increase to 2 then decr Y. 1 4 6 4 1 alone or with 0.5^4 × Y. 0.0625, 0.25, 0.375, 0.25, 0.0625 Y. P(1) = P(3) and P(2) is greater/different or equiv of any of the above	 B1B1B1	 Ignore all else	If values of <u>some</u> probs listed: 2 to 4 values: B1 Y: B1 For 3rd B1 must link list with Y diag, eg "symmetrical" or "peak in middle" or "peak at 2" or "1st = last" or "2nd = 4th" "same shape as Y diag". etc etc
			If none of the above applies: Any implication that values not all equal eg: Not uniform or values increase (then decrease) or there is a peak Symmetrical or mirror image oe or $^4C_0 = {}^4C_4$ or 2nd = 4th or similar or mean = 2, or E(X) = 2, or 2 is hi'est prob, or peak at 2, or peak is middle value Y	 B1 B1 B1 [3]	 $^4C_0$, $^4C_1$, $^4C_2$, etc indep indep indep	

(Q6, Jan 2012)

28	(i)		Geo(0.6) or G(0.6) or Geo with p = 0.6 P(woman) const or chance of woman const Each voter has same prob Whether one voter is a woman is indep of whether any other is a woman [4]	B1B1 B1 B1	Allow Geo(60%) B1B1 or %age of women is constant Allow: "voter(s) independent", "Men & women are independent" "P(woman) is indep" "Each woman is indep"	Bin(…, 0.6) B0B1. Can still score comment marks In context Allow "vote indep" In context (EACH comment must be in context) Ignore all else
	(ii)		$0.4^3 \times 0.6$ = $^{24}/_{625}$ or 0.0384	M1 A1f [2]	ft their Geo(p) from (i) ft their Geo(p) from (i)	Allow $0.3^3 \times 0.6$ (but no other $q^3 \times 0.6$) eg if p = 0.4, ans 0.0864 M1A1f
	(iii)		0.4^3 alone, or ($0.4^4 + 0.4^3\times0.6$) or (0.4^4 + (ii)) = $^{8}/_{125}$ or 0.064	M1 A1f [2]	1–(0.6 + 0.4×0.6 + $0.4^2\times0.6$) (allow extra term $0.4^3\times0.6$) ft their Geo(p) from (i) ft their Geo(p) from (i)	Allow M1 for 0.4^4 alone (= 0.0256) M0 for $0.4^r \times 0.6$ and for $1 - 0.4^3$ eg if p = 0.4, ans 0.216 M1A1f

(Q7, Jan 2012)

29	(i)		Binomial stated $1 - 0.9648$ $= 0.0352$ (3 sfs) or $^{9}/_{256}$	M1 M1 A1 [3]	or implied by $C \times 0.5^r$ or use of table or $^8C_7 \times 0.5^7 \times 0.5 + 0.5^8$ fully correct method	or $0.5^7 \times 0.5 + 0.5^8$ or $0.5^8 + 0.5^8$ $1 - (0.5^8 + 8 \times 0.5^8 + {}^8C_2 0.5^8 \ldots)$ all correct
	(ii)	(a)	$^{22}C_{11} \times 0.5^{11} \times 0.5^{11}$ $= 0.168$ (3 sfs)	M1 A1 [2]	Fully correct method. Not ISW	eg 0.168^2 or 2×0.168 or $1 - 0.168$: M0A0
	(ii)	(b)	$1 -$ "0.168" $^1/_2(1 -$ "0.168") $= 0.416$ (3 sfs)	M1 M1 A1 [3]	or $0.5^{22}(^{22}C_{12} + {}^{22}C_{13} + {}^{22}C_{14} + \ldots + 22 + 1)$ All 11 correct terms seen, or correct ans: M2 or P(X = 12, 13, … 21, 22) stated or implied with $\geq$ 2 terms shown or one extra term M1	or $1 - (^{22}C_{12} + {}^{22}C_{13} + {}^{22}C_{14} + \ldots + 22 + 1)$ $1 -$ all 12 correct terms M2 or similar marks for P(X = 10, 9, 8…0)

(Q8, Jan 2012)

30	(i)		$1 - 0.1754$ alone $= 0.825$ (3 sfs)	M1 A1 **[2]**	Allow $1 - 0.2855$ or 0.7145 or 0.715 alone	
	(ii)	(a)	$^4C_2 \times 0.7^2 \times 0.3^2$ $= \frac{1323}{5000}$ or 0.265 (3 sf)	M1 A1 **[2]**	All correct	
	(ii)	(b)	4,4,2 & 4,3,3 only, seen or implied P(Y = 4) = 0.7^4 (or $\frac{2401}{10000}$ or 0.2401) P(Y = 3) = $4 \times 0.3 \times 0.7^3$ (or $\frac{1029}{2500}$ or 0.4116) P(4,3,3) = $3 \times$ "0.2401" $\times$ "0.4116"^{2} (or 0.122) P(4,4,2) = 3×0.2401"$^2 \times$ "0.265" (or 0.0458) P(Tot = 10) = 0.168 (3 sfs)	B1 M1 M1 M1 M1 A1 **[6]**	Both needed ie $3 \times$ their P(4) $\times$ (their P(3))^2 ie $3 \times$ (their P(4))$^2 \times$ their P(2) ft (ii)(a) For M mks ignore extra combs eg P(4,4,3) If B(30, 0.6) clearly being used: Any 5 combs adding to 10 seen B1 P(8) = $^{30}C_8 \times 0.4^{22} \times 0.6^8$ or 0.0002 P(9) = $^{30}C_9 \times 0.4^{21} \times 0.6^9$ or 0.0007 P(10) = $^{30}C_{10} \times 0.4^{20} \times 0.6^{10}$ or 0.0020 all three correct M2 or two correct M1 No more marks	if "3×" omitted twice or "3!×" used twice allow M1M0 eg ans 0.0560, 0.0559,0.336, probably B1M1M1M1M0A0 but must see method

(Q8, June 2012)

31	(i)	(a)	Geo stated or implied $0.9^5 \times 0.1$ alone = 0.059(0…) (2 sfs)	M1 M1 A1 **[3]**	eg by $0.9^p \times 0.1$ or $0.1^p \times 0.9$ alone, $p>1$ all correct	
	(i)	(b)	0.9^5 or 0.59… (NB cf ans to (i)(a)!!) $1 - 0.9^5$ = 0.4095 or 0.410 (3 sfs)	M1 M1 A1 **[3]**	$0.1 + 0.9\times0.1 + \ldots 0.9^4\times0.1$: M2 1 term wrong or omit or extra or 1 – (all terms correct): M1 or $1 - 0.9^6$: M1	M0M0A0 for $0.9^p \times 0.1$
	(ii)	(a)	$0.05 + 0.95^2\times 0.05$ = $\frac{761}{8000}$ or 0.0951 (3 sfs)	M1 A1 **[2]**	All correct	NB!! $2 \times 0.95 \times 0.05 = 0.095$ M0A0
	(ii)	(b)	0.05, $0.95^2\times 0.05$, … or $\frac{1}{20}$, $\frac{361}{8000}$, … oe $\frac{0.05}{1-0.95^2}$ or $\frac{0.05}{1-0.9025}$ oe = $\frac{20}{39}$ or 0.513 (3 sfs)	M1 M1 A1 **[3]**	$\geq$ 2 terms. Not nec'y added May be implied by next line or $\frac{0.05}{1-(1-0.5)^2}$ or $\frac{0.05}{2\times0.05-0.05^2}$ or $\frac{1}{1.95}$ oe	or $r = 0.95^2$ stated or implied NB $\frac{0.05}{1-0.5\times0.05} = 0.0513$ M0A0

(Q9, June 2012)

32			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 $(= \frac{59049}{1048576})$ $(\frac{3}{4})^5\times5(\frac{3}{4})^4(\frac{1}{4})$ 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 $\leq$ 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 ${}^{10}C_3 \times (1 - '0.2637')^7 \times '0.2637'^3$ = 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 ${}^{10}C_3\times(1-'0.282')^7\times'0.282'^3$ M0M1 (0.282 comes from P(3 totals = 2))

(Q5, Jan 2013)

33	**(i)**	**(a)**	$0.9^4 \times 0.1$ $= \frac{6561}{100000}$ or 0.0656 (3sf)	M1 A1 **[2]**		
	(i)	**(b)**	0.9^5 $= \frac{59049}{100000}$ or 0.59 (2 sf)	M1 A1 **[2]**	Allow 0.9^4 or $1–0.9^5$:M1 but $1–0.9^n$ ($n \neq 5$) or 0.1×0.9^n :M0	$1 – (0.1+0.9\times0.1+0.9^2\times0.1 + \ldots 0.9^4\times0.1)$ Allow without "1 –" OR omit last term NB $0.9^5\times0.1 = 0.0590$ M0A0
	(i)	**(c)**	0.1×0.1 or $[0.1\times0.1\times0.9 + 0.1\times0.1\times0.1]$ oe $+ 0.1\times0.9\times0.1$ oe $+ 0.9\times0.1\times0.1$ oe $= 0.028$ **[4]**	M1 M1 M1 A1 or SS, FSS, SFS seen or implied: B1	M1M1 two correct terms, no incorrect multiples M1 all correct Ans 0.027 probably M0M1M1A0 but check working SC if no M-mks scored: SSF, SSS, FSS, SFS	$3\times0.1^2\times0.9+0.1^3$ no incorrect multiples M2 for 1st term; M1 for 2nd This method only scores using "1 – ": 0.9^3; $3\times0.9^2\times0.1$ no incorrect multiples M1; M1 1 – one or both terms with no further wking: M1(dep M1) eg $1 – 0.9^3$ alone M1M0M1
	(ii)	**(a)**	$0.9\times 0.8 \times 0.1$ $= \frac{9}{125}$ or 0.072	M1 A1 **[2]**	alone or allow × 0.8 (ie girls in wrong order) (= 0.0576)	NOT $0.9\times0.8\times0.1\times0.2= 0.0144$: M0A0 NOT $0.9\times0.8\times0.2= 0.144$: M0A0
	(ii)	**(b)**	$0.9^{9 \text{ or } 10} \times 0.8^{9 \text{ or } 10} \times 0.1$ (or ×0.2, not ×0.1×0.2) $(0.9 \times 0.8)^9 \times 0.1$ oe $= 5.2\times10^{-3}$ or 0.0052 (2 sf)	M1 M1 A1 **[3]**	allow $0.9^{9 \text{ or } 10} \times 0.8^{9 \text{ or } 10} \times 0.1 \times {}^{18,19,20}C_1$ fully correct SC Consistent use of 0.8 for both girls: **(ii)(a)** 0.128 **(ii)(b)** 0.00360 or 0.9 for both girls: **(ii)(a)** 0.081 **(ii)(b)** 0.0150 If both these ans seen, allow (a) 0 (b) B1	If ans = 0.00360 or 0.0150 see SC below

(Q8, Jan 2013)