

Geometric Distribution (From OCR 4732)

Q1, (Jan 2006, Q5)

(i)(a)	$(\frac{3}{5})^4 \times \frac{2}{5}$ = 0.0518 (3sfs) or $\frac{162}{3125}$ oe	M1 A1	2	Allow index 3 or 5
(b)	$(\frac{3}{5})^4$ $1 - (\frac{3}{5})^4$ = 0.870 (3 sfs) or $\frac{544}{625}$ oe	M1 M1 A1	3	$\frac{2}{5} + \frac{3}{5} \times \frac{2}{5} + (\frac{3}{5})^2 \times \frac{2}{5} + (\frac{3}{5})^3 \times \frac{2}{5}$: M2 (1extra or omit or wrong: M1) Allow $1 - (\frac{3}{5})^3$ or $1 - (\frac{3}{5})^5$
(ii)(a)	B($5, \frac{2}{5}$) stated $5 \times \frac{2}{5} \times (\frac{3}{5})^4$ or 0.3370 – 0.0778 = 0.259 (3 sfs) or $\frac{162}{625}$ oe	M1 M1 A1	3	or $({}^5C_a \text{ or } {}^5C_b) \times (\frac{2}{5})^a \times (\frac{3}{5})^b$ & $a + b = 5$
(b)	“0.259” $\times \frac{2}{5}$ = 0.104 (3 sfs) or $\frac{324}{3125}$ oe	M1 A1f	2	eg ft: (a) 0.0518 $\rightarrow$ 0.0207 (a) 0.922 $\rightarrow$ 0.369
Total			10	

Q2, (Jan 2007, Q6)

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

Q3, (Jan 2008, Q2)

i	$(\frac{4}{5})^3 \times (\frac{1}{5})$ oe = $\frac{64}{625}$ or 0.102 (3 sfs)	M1 A1	2	Allow M1 for $(\frac{4}{5})^4 \times (\frac{1}{5})$
ii	$(\frac{4}{5})^4$ alone or $1 - (\frac{1}{5} + \frac{4}{5} \times \frac{1}{5} + (\frac{4}{5})^2 \times \frac{1}{5} + (\frac{4}{5})^3 \times \frac{1}{5})$ = $\frac{256}{625}$ or 0.410 (3 sfs)	M1 A1	2	Allow $(\frac{4}{5})^3$ or $(\frac{4}{5})^5$; not $1 - (\frac{4}{5})^4$ Allow one term omitted or wrong or “correct” extra
iii	5	B1	1	Allow 0.41
Total			5	

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

Q5, (Jun 2009, Q4)

i	Geo stated $0.7^3 \times 0.3$ alone = $\frac{1029}{10000}$ 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 = $\frac{2401}{10000}$ or 0.240 (3 sf)	M1 A1 2	$1 - (0.3 + 0.7 \times 0.3 + 0.7^2 \times 0.3 + 0.7^3 \times 0.3)$ NB $1 - 0.7^4 : M0$
iii	$1 - 0.7^5$ = 0.832 (3 sfs)	M2 A1 3	or $0.3 + 0.7 \times 0.3 + + \dots + 0.7^4 \times 0.3$ M2 M1 for one term extra or omitted or wrong or for $1 - (\text{above})$ M1 for $1 - 0.7^6$ or 0.7^5 NB Beware: $1 - 0.7^6 = 0.882$
		8	

Q6, (Jan 2011, Q2)

i	$0.8^2 \times 0.2$ $= \frac{16}{125}$ or 0.128	M1 A1 2		
ii	$0.8^2 \times 0.2 + 0.8^3 \times 0.2 + 0.8^4 \times 0.2$ $= \frac{976}{3125}$ or 0.312 (3 sfs)	M2 A1 3	1 term omitted or wrong or extra: M1	Using $P(X \leq 5)$ & $P(X \leq 2)$; 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 $0.8^2 - 0.8^4$ $0.2 + 0.8 \times 0.2 + 0.8^2 \times 0.2 + 0.8^3 \times 0.2 + 0.8^4 \times 0.2 - (0.2 + 0.8 \times 0.2)$: M2 One term omitted or wrong or extra: M1 But NB If include $0.8^{-1} \times 0.2$ in both $P(X \leq 5)$ & $P(X \leq 2)$, 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	$1 - (0.2 + 0.8 \times 0.2 + 0.8^2 \times 0.2 + 0.8^3 \times 0.2)$ 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	$1 - (0.2 + 0.8 \times 0.2 + 0.8^2 \times 0.2 + 0.8^3 \times 0.2)$ 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 $\frac{8}{125}$	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 $(0.2 + 0.8 \times 0.2) \times 2$, must see method Attempt 0,3 and/or 3,0, as well as 2,1 and/or 1,2; max M1M0A0 Careful: $0.2 \times 0.8 \times 0.2 + 0.2 \times 0.8^{-1} \times 0.128 = 0.064$ M1M0A0 Careful: $0.8 \times 0.8 \times 0.2 \div 2 = 0.064$: (ie $P(X = 3) \div 2$) M0M0A0
Total		11		

Q7, (Jun 2011, Q8)

i	$\frac{25}{216}$ oe or 0.116 (3 sfs)	B1 1		
ii	$(\frac{5}{6})^7 \times \frac{1}{6}$ alone = 0.0465 (3 sfs) or $\frac{78125}{1679616}$	M2 A1 3	M1 for $(\frac{5}{6})^8 \times \frac{1}{6}$ alone	
iii	$(\frac{5}{6})^8$ oe alone = 0.233 (3 sfs) or $\frac{390625}{1679616}$	M1 A1 2	$1 - P(X \leq 8)$, with exactly 8 correct terms	NOT $1 - (\frac{5}{6})^8$, NOT $(\frac{5}{6})^8 \times \dots$
iv	NB If more than 5 products are added (eg $P(1 \leq X \leq 12)$): no marks $(\frac{5}{6})^9 \times \frac{1}{6} + (\frac{5}{6})^{10} \times \frac{1}{6} + (\frac{5}{6})^{11} \times \frac{1}{6} + (\frac{5}{6})^{12} \times \frac{1}{6}$ (= 0.0323 + 0.0268 + 0.0224 + 0.0187) = 0.100 (3 sfs)	M3 A1 4	M3 for all correct or M2 for 3 of these added or these 4 plus 1 extra or 0.0817 or 0.0680 or 0.139 or 0.116 or M1 for ≥ 1 of these terms or values seen; ignore incorrect Allow 0.1 with wking	$(\frac{5}{6})^9 - (\frac{5}{6})^{13}$ or $1 - (\frac{5}{6})^{13} - [1 - (\frac{5}{6})^9]$ M3 or $(\frac{5}{6})^{8, 9 \text{ or } 10} - (\frac{5}{6})^{12, 13 \text{ or } 14}$ or $1 - (\frac{5}{6})^{12, 13 \text{ or } 14} - [(1 - (\frac{5}{6})^{8, 9 \text{ or } 10})]$ M2 or $\pm[(\frac{5}{6})^9 - (1 - (\frac{5}{6})^{13})]$ or $\pm[1 - (\frac{5}{6})^9 - (\frac{5}{6})^{13}]$ M1
Total		10		

Q8, (Jun 2012, Q9)

(i)	(a)	Geo stated or implied $0.9^5 \times 0.1$ alone $= 0.059(0\dots)$ (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 $0.59\dots$ (NB cf ans to (i)(a)!!) $1 - 0.9^5$ $= 0.4095$ or 0.410 (3 sfs)	M1 M1 A1 [3]	$0.1 + 0.9 \times 0.1 + \dots + 0.9^4 \times 0.1$: M2 1 term wrong or omit or extra or $1 - (\text{all terms correct})$: 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)	$0.05, 0.95^2 \times 0.05, \dots$ or $\frac{1}{20}, \frac{361}{8000}, \dots$ 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]	≥ 2 terms. Not nec'y added May be implied by next line or $\frac{0.05}{1-(1-0.5)^2}$ or $\frac{0.05}{2 \times 0.05 - 0.05^2}$ or $\frac{1}{1.95}$ oe	or $r = 0.95^2$ stated or implied NB $\frac{0.05}{1-0.5 \times 0.05} = 0.0513$ M0A0

Q9, (Jan 2013, Q8)

(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	$1 - (0.1+0.9 \times 0.1+0.9^2 \times 0.1 + \dots 0.9^4 \times 0.1)$ Allow without “1 –” OR omit last term NB $0.9^5 \times 0.1 = 0.0590$ M0A0
(i)	(c)	0.1×0.1 or $[0.1 \times 0.1 \times 0.9 + 0.1 \times 0.1 \times 0.1]$ oe $+ 0.1 \times 0.9 \times 0.1$ oe $+ 0.9 \times 0.1 \times 0.1$ oe $= 0.028$	M1 M1 M1 A1 [4]	M1M1 two correct terms, <u>no incorrect multiples</u> M1 all correct Ans 0.027 probably M0M1M1A0 but check working SC if no M-mks scored: SSF, SSS, FSS, SFS or SS, FSS, SFS seen or implied: B1	$3 \times 0.1^2 \times 0.9 + 0.1^3$ <u>no incorrect multiples</u> M2 for 1st term; M1 for 2nd This method only scores using “1 –”: 0.9^3 ; $3 \times 0.9^2 \times 0.1$ <u>no incorrect multiples</u> 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 $\times 0.8$ (ie girls in wrong order) (= 0.0576)	NOT $0.9 \times 0.8 \times 0.1 \times 0.2 = 0.0144$: M0A0 NOT $0.9 \times 0.8 \times 0.2 = 0.144$: M0A0
(ii)	(b)	$0.9^{9 \text{ or } 10} \times 0.8^{9 \text{ or } 10} \times 0.1$ (or $\times 0.2$, not $\times 0.1 \times 0.2$) $(0.9 \times 0.8)^9 \times 0.1$ oe $= 5.2 \times 10^{-3}$ 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	<u>If ans = 0.00360 or 0.0150 see SC below</u>

Q10, (Jun 2013, Q9)

(i)	(a)	$0.8^{10} \times 0.2$ $= 0.0215$ (3 sf)	M1 A1 [2]	Allow $0.8^9 \times 0.2$ or $0.8^{11} \times 0.2$ or 0.0268 or 0.0172	If $0.8 \leftrightarrow 0.2$, see above
(i)	(b)	0.8^{10} or 0.107.... $1 - 0.8^{10}$ alone $= 0.893$ (3 sf)	M1 M1 A1 [3]	Not $0.8^{10} \times \dots$ M0M0 Not just 0.8^9 or 0.8^{11} M0M0 Allow M1 for $1 - 0.8^9$ or $1 - 0.8^{11}$ alone or 0.866 or 0.914	$0.2 + 0.8 \times 0.2 + \dots + 0.8^9 \times 0.2$ (10 terms) M2 Allow M1 for 1 term omitted or extra Allow use of dots as above, for M1 or M2, so long as their 1 st & last and one other term seen If $0.8 \leftrightarrow 0.2$, see above
(ii)		$\frac{1}{0.2}$ alone $= 5$	M1 A1 [2]	(5, 1) M1A0	Allow $1 \div$ their incorrect p used in (i)(a) Ignore eg “E(X) =” If $1 \div 0.8 = 1.25$, see above
(iii)		4 Allow (4, 1)	B1ft [1]	or (ii) – 1 or (ii) $\times 0.8$	ft (their (ii)–1, 1)

Q11, (Jun 2014, Q9)

(i)	$0.7^4 \times 0.3$ alone $= 0.0720$ (3 sf) or $\frac{7203}{100000}$ oe	M1 A1 [2]	allow 0.072	
(ii)	$(0.7 + 0.7^2 + 0.7^3) \times 0.3$ $= 0.4599$ or 0.460 (3sf) or $\frac{4599}{10000}$ oe	M2 A1 [3]	M1 for 1 term omitted, wrong or extra. must add terms, not mult. Allow 0.46	$(1 - 0.7^4) - 0.3$ or $0.7599 - 0.3$ M2 $(1 - 0.7^4) - \dots$ or $1 - 0.3 - \dots$ M1 $0.7599 - \dots$ or $0.7 - \dots$ M1 Just $1 - 0.7^4$ or $1 - 0.3$: M0 $(1 + 0.7 + 0.7^2 + 0.7^3) \times 0.3 - 0.3$ M2 1 term omitted, wrong or extra M1
(iii)	$1 - 0.7^6$ $= 0.882$ (3 sf)	M2 A1 [3]	M1 for 0.7^6 alone or $1 - 0.7^5 (= 0.832)$ or $1 - 0.7^7 (= 0.918)$	$0.3(1 + 0.7 + 0.7^2 + 0.7^3 + 0.7^4 + 0.7^5)$ M2 or (ii) + $0.3(1 + 0.7^4 + 0.7^5)$ M2 or (i) + (ii) + $0.3(1 + 0.7^5)$ M2 one term omitted or extra: M1 must add terms, not mult. NB ans 0.832 might be M1M0A0 from omitting last term. Could be, eg, their (ii) + $0.3(1 + 0.7^4)$ correct working, but subtr from 1: M1
(iv)	$(1 - "0.882")^2 \times "0.882"$ oe $= 0.0122$ (3 sf)	M1 A1ft [2]	or $(0.7^6)^2 \times (1 - 0.7^6)$ or $0.1176^2 \times (1 - 0.1176)$ or $(0.7^6)^2 \times$ their "0.882" or $0.3(0.7^{12} + (0.7^{13} + 0.7^{14} + \dots + 0.7^{17}))$ allow 0.0123	Not $0.7^2 \times 0.3$ Completely correct method ft their "0.882" except if 0.3 or 0.7

Q12, (Jun 2015, Q5)

(i)	(a)	$(1 - 0.27)^7 \times 0.27$ $= 0.0298$ (3 sf)	M1 A1 [2]	alone	
(i)	(b)	$(1 - 0.27)^8$ $= 0.0806$ (3 sf) or 0.08065	M1 A1 [2]	alone or $1 - P(X = 1, 2, 3, 4, 5, 6, 7, 8)$ all terms correct ($= 1 - 0.91935$)	NOT $(1 - 0.27)^8 \times \dots$ NOT $1 - (1 - 0.27)^8$
(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	or by ans 0.309. Allow "Bio" Allow correct + Correct ans, no working: B1B0B1
(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 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	or ${}^8C_2 \times (1 - 0.27)^8 \times 0.27^4$ SC: $(1 - 0.27)^8 \times 0.27^4$ oe alone M0M1A0

Q13, (Jun 2016, Q7)

i		Const prob of scoring Each shot indep	oe oe	B1 B1 [2]	In context Not 'Prob of goal is <u>consistent</u> ' In context Ignore incorrect comments	Prob score on one shot not affected by other shots Each shot indep of previous shot Allow Goals are independent Allow Prob of goals are independent <u>Not</u> Number of goals indep
ii	a	$0.8^2 \times 0.2$ $= 0.128$ or $\frac{16}{125}$ oe		M1 A1 [2]		
ii	b	$1 - 0.8^9$ $= 0.866$ (3 sf) (0.865782 . . .)		M1 A1 [2]		Long method: all 9 terms correct: M1
ii	c	$0.8^9 - 0.8^{19}$ or $1 - 0.8^{19} - (1 - 0.8^9)$ or $1 - '0.866' - 0.8^{19}$ or $1 - 0.8^{19} - '0.866'$ $= 0.120$ (3 sf)		M2 A1 [3]	Allow M1 for $0.8^{8,9 \text{ or } 10} - 0.8^{18,19 \text{ or } 20}$ or $1 - 0.8^{18,19 \text{ or } 20} - (1 - 0.8^{8,9 \text{ or } 10})$ Allow 0.12	Long method: all 10 terms correct: M2 1 term extra, omitted or incorrect: M1

7(iii)(a) & (iii)(b): SC If 0.2 and 0.3 interchanged, or If 0.3 replaced by $\frac{1}{3}$, consistently throughout (iii)(a) and (iii)(b),

all three M-marks can be awarded if consistent working seen OR 'correct' answer with no working.

Answers: $0.2 \leftrightarrow 0.3$: (iii)(a) 0.09 (iii)(b) 0.0364

Use of $\frac{1}{3}$: (iii)(a) 0.04 (iii)(b) $\frac{8}{75}$ or 0.107

	iii	a	$0.2 \times 0.3 \times 0.2 + 0.2 \times 0.7 \times 0.2$ alone $= 0.04$ or $\frac{1}{25}$ oe	M1 A1 [2]	or 0.2×0.2	
	iii	b	$0.2 \times 0.3 \times 0.8 \times 0.3 + 0.8 \times 0.3 \times 0.2 \times 0.3$ $+ 0.8 \times 0.3 \times 0.8 \times 0.3$ alone oe or $0.3 \times 0.8 \times 0.3 + 0.8 \times 0.3 \times 0.2 \times 0.3$ oe $= 0.0864$ or $\frac{54}{625}$ oe	M2 A1 [3]	or $(0.2 \times 0.8 \times 2 + 0.8^2) \times 0.3^2$ oe M2 or $\frac{9}{625} + \frac{9}{625} + \frac{36}{625}$ oe M2 or any two correct prods of 4 probs oe :M1 If on tree, must be identified $0.3 \times 0.8 \times 0.3$ M0 unless part of a correct method	$(1 - 0.2^2) \times 0.3^2$ or $(1 - 0.04) \times 0.3^2$ oe M2 or $1 - 0.2^2$ or $1 - 0.04$ M1
Total				14		