A level Mathematics Practice Paper – Geometric sequences and series – Mark scheme

Question	Scheme	Marks
1(a)	$\frac{a\left(1-\left(\frac{3}{4}\right)^4\right)}{1-\frac{3}{4}}$ or $\frac{a\left(1-\frac{3}{4}^4\right)}{1-\frac{3}{4}}$ or $\frac{a\left(1-0.75^4\right)}{1-0.75}$	M1
	$175=\frac{a\left(1-\left(\frac{3}{4}\right)^4\right)}{1-\frac{3}{4}} \Rightarrow a=\frac{175\left(1-\frac{3}{4}\right)}{\left(1-\left(\frac{3}{4}\right)^4\right)}$ $\left\{\Rightarrow a=\frac{\left(\frac{175}{4}\right)}{\left(\frac{175}{256}\right)}\Rightarrow\right\}$ $\underline{a=64}$ *	A1*
		(2)
1(b)	$\{S_\infty\}=\frac{64}{\left(1-\frac{3}{4}\right)}$; $=256$	M1
		A1 cao
		(2)
1(c)	$\{D=T_9-T_{10}=\}$ $64\left(\frac{3}{4}\right)^8-64\left(\frac{3}{4}\right)^9$	M1
		dM1
	$\left\{=64\left(\frac{3}{4}\right)^8\left(\frac{1}{4}\right)=1.6018066...\right\}=\underline{1.602}$ (3dp)	A1 cao
		(3)
		(7 marks)
2(a)	Uses $360\times\left(\frac{7}{8}\right)^{19}$, to obtain 28.5	M1 A1
		(2)
2(b)	Uses $S=\frac{360(1-(\frac{7}{8})^{20})}{1-\frac{7}{8}}$, or $S=\frac{360((\frac{7}{8})^{20}-1)}{\frac{7}{8}-1}$ to obtain 2680	M1 A1
		(2)
2(c)	Uses $S=\frac{360}{1-\frac{7}{8}}$, to obtain 2880	M1 A1 cao
		(2)
		(6 marks)

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Question	Scheme	Marks
3(a)	$\frac{a}{1-r} = 6a$	M1
	$\{\Rightarrow 1 = 6(1-r) \Rightarrow\}\ r = \frac{5}{6}$*	A1*
		(2)
3(b)	$\left\{T_4 = ar^3 = 62.5 \Rightarrow\right\}\ a\left(\frac{5}{6}\right)^3 = 62.5$	M1
	$\Rightarrow a = 108$	A1
		(2)
3(c)	$S_\infty = 6(\text{their } a)$ or $\frac{\text{their } a}{1-\frac{5}{6}}\{= 648\}$	M1
	$\{S_{30} =\}\ \frac{108\left(1-(\frac{5}{6})^{30}\right)}{1-\frac{5}{6}}\ \{= 645.2701573...\}$	M1 A1ft
	$\{S_\infty - S_{30}\} = 2.72984...$ **awrt** 2.73	A1
		(4)
		(8 marks)

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Question	Scheme		Marks
4(a)	$120000\times(1.05)^3=138915$ *	Or $120000\times1.05\times1.05\times1.05=138915$ Or 120000, 126000, 132300, 138915 Or a = 120000 and $a\times(1.05)^3=138915$	B1
			(1)
4(b)	$120000\times(1.05)^{n-1}>200000$	Allow n or $n-1$ and ">", "<", or "=" etc.	M1
	$\log1.05^{n-1}>\log\left(\frac{5}{3}\right)$	Takes logs correctly Allow n or $n-1$ and ">", "<", or "=" etc.	M1
	$(n-1>)\frac{\log\left(\frac{5}{3}\right)}{\log1.05}$ or equivalent e.g. $(n>)\frac{\log\left(\frac{7}{4}\right)}{\log1.05}$	Allow n or $n-1$ and ">", "<", or "=" etc. Allow $1.\dot{6}$ or awrt 1.67 for 5/3.	A1
	2024	M1: Identifies a calendar year using their value of n or $n-1$	M1 A1
			(5)
4(c)	$\frac{a(1-r^n)}{1-r}=\frac{120000\left(1-1.05^{11}\right)}{1-1.05}$	M1: Correct sum formula with n = 10, 11 or 12	M1 A1
		A1: Correct numerical expression with n = 11	
	1704814	Cao (Allow 1704814.00)	A1
			(3)
			(9 marks)

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Question	Scheme		Marks
5(a)	$ar = 750$ and $ar^4 = -6$ (could be implied from later working in either (a) or (b)).		B1
	$r^3 = \dfrac{-6}{750}$		M1
	$r = -\dfrac{1}{5}$	Correct answer from no working, except for special case below gains all three marks.	A1
			(3)
5(b)	$a(-0.2) = 750$		M1
	$a\left\{= \dfrac{750}{-0.2}\right\} = -3750$		A1 ft
			(2)
5(c)	Applies $\dfrac{a}{1-r}$ correctly using both their a and their $\lvert r\rvert < 1$. Eg. $\dfrac{-3750}{1--0.2}$		M1
	So, $S_\infty = -3125$		A1
			(2)
			(7 marks)

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Question	Scheme		Marks
6(a)	$\{ ar = 192 \quad \text{and} \quad ar^2 = 144 \}$		
	$r = \dfrac{144}{192}$	Attempt to eliminate a.	M1
	$r = \frac{3}{4}$ or 0.75	$\frac{3}{4}$ or 0.75	A1
			(2)
6(b)	$a(0.75) = 192$		M1
	$a\left\{= \dfrac{192}{0.75}\right\} = 256$	256	A1
			(2)
6(c)	$S_\infty = \dfrac{256}{1-0.75}$	Applies $\dfrac{a}{1-r}$ correctly using both their a **and** their $\lvert r\rvert < 1$.	M1
	So, $\{S_\infty =\}\ 1024$	1024	A1 cao
			(2)
6(d)	$\dfrac{256(1-(0.75)^n)}{1-0.75} > 1000$	Applies S_n with their a and r and "uses" 1000 at any point in their working. (Allow with = or <).	M1
	$(0.75)^n < 1 - \dfrac{1000(0.25)}{256} \left\{= \dfrac{6}{256}\right\}$	Attempt to isolate $+(r)^n$ from S_n formula. (Allow with = or >).	M1
	$n\log(0.75) < \log\left(\dfrac{6}{256}\right)$	Uses the power law of logarithms correctly. (Allow with = or >).	M1
	$n > \dfrac{\log\left(\frac{6}{256}\right)}{\log(0.75)} = 13.0471042... \Rightarrow n = 14$	$n = 14$	A1 **cso**
			(4)
			(10 marks)

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Question	Scheme	Marks
7(a)	$a = 7k-5,\ ar = 5k-7$ and $ar^2 = 2k+10$	B1
	(So r =) $\dfrac{5k-7}{7k-5} = \dfrac{2k+10}{5k-7}$ or $(7k-5)(2k+10) = (5k-7)^2$ or equivalent	M1
	See $(5k-7)^2 = 25k^2 - 70k + 49$	M1
	$14k^2 + 60k - 50 = 25k^2 - 70k + 49 \rightarrow 11k^2 - 130k + 99 = 0$ *	A1cso *
		(4)
7(b)	$(k-11)(11k-9)$ so k =	M1
	k = 9/11 only* (after rejecting 11)	A1*
	N.B. Special case k = 9/11 can be verified in (b) (1 mark only) $11\times\left(\frac{9}{11}\right)^2 - 130\times\left(\frac{9}{11}\right) + 99 = \frac{81}{11} - \frac{1170}{11} + \frac{1089}{11} = 0$ M1A0	
		(2)
7(c)	$a = \dfrac{8}{11}$	B1
	$\dfrac{5\times\frac{9}{11}-7}{7\times\frac{9}{11}-5}$ *or* $\dfrac{2\times\frac{9}{11}+10}{5\times\frac{9}{11}-7}$ so $r = -4$	B1
	(i) Fourth term = $ar^3 = -\dfrac{512}{11}$	M1A1
	(ii) $S_{10} = \dfrac{a(1-r^{10})}{(1-r)} = \dfrac{\frac{8}{11}(1-(-4)^{10})}{(1-(-4))} = -152520$	M1A1
		(6)
		(12 marks)

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Question	Scheme		Marks
8(a)	$(S_n =)\ \ a + ar + (ar^2) + \ldots \quad + ar^{n-1}$ **and** $rS_n = ar + ar^2 + (ar^3) \ldots \quad + ar^n$		M1
	$S_n - rS_n = a - ar^n$		M1
	$S_n(1-r) = a(1-r^n)$		dM1
	And so result $S_n = \dfrac{a(1-r^n)}{(1-r)}$ *		A1
			(4)
8(b)	Divides one term by other (either way) to give $r^2 = \ldots$ then square roots to give $r =$	**Or:** (*Method 2)* Finds geometric mean i.e 3.24 and divides one term by 3.24 or 3.24 by one term	M1
	$r^2 = \dfrac{1.944}{5.4}$, $r = 0.6$ (ignore – 0.6)	$r = 0.6$ (ignore – 0.6)	A1
			(2)
8(c)	Uses $5.4 \div r^2$ or $1.944 \div r^4$, to give $a =$		M1
	$a = 15$		A1ft
			(2)
8(d)	Uses $S = \dfrac{15}{1-0.6}$, to obtain 37.5		M1 A1 A1
			(3)
			(11 marks)

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	Source paper	Question number	New spec references	Question description	New AOs
1	C2 2016	1	4.5	Sequences and series	1.1b and 2.1
2	C2 Jan 2012	1	4.5	Geometric sequences and series	1.1b
3	C2 June 2014R	2	4.5	Geometric sequences and series	1.1b
4	C2 Jan 2013	3	4.5, 6.3 and 6.5	Geometric sequences and series	1.1b, 2.2a and 2.4
5	C2 Jan 2011	3	4.5	Geometric sequences and series	1.1b
6	C2 2011	6	4.5	Geometric sequences and series	1.1b, 2.2a
7	C2 2017	9	4.5	Geometric sequence	1.1b, 2.1, 2.2a
8	C2 2012	9	4.5	Geometric sequences and series	2.1, 1.1b