Modelling with Series - Edexcel Past Exam Questions MARK SCHEME

Question 1: June 05 Q9

Question number	Scheme	Marks
	(a) $(S =)\ a + ar + ... + ar^{n-1}$ "$S =$" not required. Addition required.	B1
	$(rS =)\ ar + ar^2 + ... + ar^n$ "$rS =$" not required (M: Multiply by r)	M1
	$S(1-r) = a(1-r^n)$ $S = \dfrac{a(1-r^n)}{1-r}$ (M: Subtract and factorise) (*)	M1 A1cso (4)
	(b) $ar^{n-1} = 35000 \times 1.04^3 = 39400$ (M: Correct a and r, with $n = 3$, 4 or 5).	M1 A1 (2)
	(c) $n = 20$ (Seen or implied)	B1
	$S_{20} = \dfrac{35000(1-1.04^{20})}{(1-1.04)}$	M1 A1ft
	(M1: Needs <u>any</u> r value, $a = 35000$, n =19, 20 or 21).	
	(A1ft: ft from n =19 or n =21, but r must be 1.04).	
	= 1 042 000	A1 (4)
		10
	(a) B1: At least the 3 terms shown above, and no extra terms. A1: Requires a completely correct solution. <u>Alternative for the 2 M marks</u>: M1: Multiply numerator and denominator by $1 - r$. M1: Multiply out numerator convincingly, and factorise. (b) M1 can also be scored by a "year by year" method. <u>Answer only:</u> 39 400 scores full marks, 39 370 scores M1 A0. (c) M1 can also be scored by a "year by year" method, <u>with terms added</u>. In this case the B1 will be scored if the correct number of years is considered. <u>Answer only:</u> Special case: 1 042 000 scores 2 B marks, scored as 1, 0, 0, 1 (Other answers score no marks). <u>Failure to round correctly in (b) and (c):</u> Penalise once only (first occurrence).	

Question 2: June 07 Q8

Question number	Scheme	Marks
	(a) $50\,000r^{n-1}$ (or equiv.) (Allow ar^{n-1} if $50\,000r^{n-1}$ is seen in (b))	B1 (1)
	(b) $50\,000r^{n-1} > 200000$ (Using answer to (a), which must include r and n, and 200 000) (Allow equals sign or the wrong inequality sign) (Condone 'slips' such as omitting a zero)	M1
	$r^{n-1} > 4 \quad \Rightarrow \quad (n-1)\log r > \log 4$ (Introducing logs and dealing correctly with the power) (Allow equals sign or the wrong inequality sign)	M1
	$n > \frac{\log 4}{\log r} + 1$ (*)	A1cso (3)
	(c) $r = 1.09$: $n > \frac{\log 4}{\log 1.09} + 1$ or $n - 1 > \frac{\log 4}{\log 1.09}$ $(n > 17.086...)$ (Allow equality)	M1
	Year 18 or 2023 (If one of these is correct, ignore the other)	A1 (2)
	(d) $S_n = \frac{a(1-r^n)}{1-r} = \frac{50000(1-1.09^{10})}{1-1.09}$	M1 A1
	£760 000 (Must be this answer… nearest £10000)	A1 (3)
		9
	(b) <u>Incorrect</u> inequality sign at any stage loses the A mark. Condone missing brackets if otherwise correct, e.g $n-1\log r > \log 4$. <u>A common mistake:</u> $50\,000r^{n-1} > 200000$ M1 $(n-1)\log 50\,000r > \log 200000$ M0 ('Recovery' from here is not possible). (c) Correct answer with no working scores full marks. Year 17 (or 2022) with no working scores M1 A0. Treat other methods (e.g. "year by year" calculation) as if there is no working. (d) M1: Use of the correct formula with $a = 50000$, 5000 or 500000, and $n = 9$, 10, 11 or 15. M1 can also be scored by a "year by year" method, <u>with terms added</u>. (Allow the M mark if there is evidence of adding 9, 10, 11 or 15 terms). 1st A1 is scored if 10 correct terms have been added (allow "nearest £100"). (50000, 54500, 59405, 64751, 70579, 76931, 83855, 91402, 99628, 108595) <u>No</u> working shown: Special case: 760 000 scores 1 mark, scored as 1, 0, 0. (Other answers with no working score no marks).	

Question 3: Jan 10 Q6

Question Number	Scheme	Marks
(a)	$18000\times(0.8)^3 \quad = £9216$ * [may see $\frac{4}{5}$ or 80% or equivalent].	B1cso (1)
(b)	$18000\times(0.8)^n < 1000$	M1
	$n\log(0.8) < \log(\frac{1}{18})$	M1
	$n > \frac{\log(\frac{1}{18})}{\log(0.8)} = 12.952....$ so $n = 13$.	A1 cso (3)
(c)	$u_5 = 200\times(1.12)^4$, $= £314.70$ or $£314.71$	M1, A1 (2)
(d)	$S_{15} = \frac{200(1.12^{15}-1)}{1.12-1}$ or $\frac{200(1-1.12^{15})}{1-1.12}$, = 7455.94….. awrt £7460	M1A1, A1 (3) [9]
(a)	B1 NB Answer is printed so **need working**. May see as above or ×0.8 in three steps giving 14400, 11520, 9216. Do not need to see £ sign but should see 9216 .	
(b)	1st M1 for an attempt to use nth term and 1000. Allow n or $n-1$ and allow > or = 2nd M1 for use of logs to find n Allow n or $n-1$ and allow > or = A1 Need $n = 13$ This is an accuracy mark and must follow award of both M marks but should not follow incorrect work using $n-1$ for example. Condone slips in inequality signs here.	
(c)	M1 for use of their a and r in formula for 5th term of GP A1 cao need one of these answers – answer can imply method here NB 314.7 – A0	
(d)	M1 for use of sum to 15 terms of GP using their a and their r (allow if formula stated correctly and one error in substitution, but must use n not n - 1) 1st A1 for a fully correct expression (not evaluated)	
	Alternative Methods	
(b)	Trial and Improvement See 989.56 (or 989 or 990) identified with 12, 13 or 14 years for first **M1** See 1236.95 (or 1236 or 1237) identified with 11, 12 or 13 years for second **M1** Then $n = 13$ is **A1 (needs both Ms)** **Special case** $18000\times(0.8)^n < 1000$ so $n = 13$ as 989.56<1000 is M1M0A0 (not discounted $n = 12$)	
(c)	May see the terms 224, 250.88, 280.99, 314.71 with a small slip for M1 A0, or done accurately for M1A1	
(d)	Adds 15 terms 200 + 224 + 250.88+… + (977.42) **M1** Seeing 977… is **A1** Obtains answer 7455.94 **A1** or awrt £7460 NOT 7450	

Question 4: June 10 Q9

Question Number	Scheme	Marks
	(a) $25\,000 \times 1.03 = 25750$ $\left\{25000 + 750 = 25750, \text{ or } 25000\frac{(1-0.03^2)}{1-0.03} = 25750\right\}$ (*)	B1 (1)
	(b) $r = 1.03$ Allow $\frac{103}{100}$ or $1\frac{3}{100}$ but no other alternatives	B1 (1)
	(c) $25\,000r^{N-1} > 40\,000$ (Either letter r or their r value) Allow '=' or '<' $r^M > 1.6 \Rightarrow \log r^M > \log 1.6$ Allow '=' or '<' (See below) OR (by change of base), $\log_{1.03} 1.6 < M \Rightarrow \frac{\log 1.6}{\log 1.03} < M$ $(N-1)\log 1.03 > \log 1.6$ (Correct bracketing required) (*) Accept work for part (c) seen in part (d)	M1 M1 A1 cso (3)
	(d) Attempt to evaluate $\frac{\log 1.6}{\log 1.03} + 1$ {or $25000(1.03)^{15}$ and $25000(1.03)^{16}$} $N = 17$ (not 16.9 and not e.g. $N \geq 17$) Allow '17th year' Accept work for part (d) seen in part (c)	M1 A1 (2)
	(e) Using formula $\frac{a(1-r^n)}{1-r}$ with values of a and r, and $n = 9$, 10 or 11 $\frac{25\,000(1-1.03^{10})}{1-1.03}$ 287 000 (must be rounded to the nearest 1 000) Allow 287000.00	M1 A1 A1 (3) **10**

(c) 2nd M: Requires $\frac{40000}{25000}$ to be dealt with, and 'two' logs introduced.
With, say, N instead of $N-1$, this mark is still available.

> Jumping straight from $1.03^{N-1} > 1.6$ to $(N-1)\log 1.03 > \log 1.6$ can score only M1 M0 A0.
> (The intermediate step $\log 1.03^{N-1} > \log 1.6$ must be seen).

Longer methods require correct log work throughout for 2nd M, e.g.:

$$\log(25\,000r^{N-1}) > \log 40\,000 \Rightarrow \log 25\,000 + \log r^{N-1} > \log 40\,000 \Rightarrow$$
$$\log r^{N-1} > \log 40\,000 - \log 25000 \Rightarrow \log r^{N-1} > \log 1.6$$

(d) Correct answer with no working scores both marks.
Evaluating $\log\left(\frac{1.6}{1.03}\right) + 1$ does not score the M mark.

(e) M1 can also be scored by a "year by year" method, with terms added.
(Allow the M mark if there is evidence of adding 9, 10 or 11 terms).
1st A1 is scored if the 10 correct terms have been added (allow terms to be to the nearest 100).
To the nearest 100, these terms are:
25000, 25800, 26500, 27300, 28100, 29000, 29900, 30700, 31700, 32600

No working shown: Special case: 287 000 scores 1 mark, scored on ePEN as 1, 0, 0.
(Other answers with no working score no marks).