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EDEXCEL A LEVEL MATHEMATICS: QUESTIONS BY TOPIC

Sequences and Series (4)

A Level Mathematics Topic 4

11 questions · 70 marks · Mark schemes included

Pearson Edexcel A Level Mathematics (9MA0), June 2018 - June 2025

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 info@guidemygrades.com

 Piccadilly Business Centre, Unit C, Aldow Enterprise Park
Blackett Street, Manchester, M12 6AE

HOW TO USE THIS BOOKLET

Questions are grouped by specification sub-topic and run from the lowest mark tariff to the highest within each one.

Click any row below to jump straight to that sub-topic or question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

QUESTION	SOURCE	MARKS	PAGE
4.4 ARITHMETIC SEQUENCES AND SERIES		5 Qs · 27 marks	3
1. Q1	Paper 2: Pure Mathematics 2 November2021	4	4
2. Q2	Paper 2: Pure Mathematics 2 June2024	5	6
3. Q8 <i>also Topic 5</i>	Paper 2: Pure Mathematics 2 June2023	6	8
4. Q13	Paper 1: Pure Mathematics 1 June2022	7	12
5. Q3	Paper 1: Pure Mathematics 1 June2025	5	16
4.5 GEOMETRIC SEQUENCES AND SERIES		5 Qs · 37 marks	18
6. Q5	Paper 1: Pure Mathematics 1 November2021	6	19
7. Q9 <i>also Topic 1</i>	Paper 1: Pure Mathematics 1 June2024	6	21
8. Q9	Paper 1: Pure Mathematics 1 June2023	7	23
9. Q15 <i>also Topic 1</i>	Paper 2: Pure Mathematics 2 October2020	8	25
10. Q15 <i>also Topic 5</i>	Paper 2: Pure Mathematics 2 June2022	10	29
4.6 SEQUENCES AND SERIES IN MODELLING		1 Qs · 6 marks	33
11. Q5	Paper 1: Pure Mathematics 1 October2020	6	34



QUESTIONS

11 questions · 70 marks · 3 sub-topics



SUB-TOPIC 4.4

ARITHMETIC SEQUENCES AND SERIES

Sub-topic 4.4 · 5 questions · 27 marks · lowest tariff first



1. In an arithmetic series

- the first term is 16
- the 21st term is 24

(a) Find the common difference of the series.

(2)

(b) Hence find the sum of the first 500 terms of the series.

(2)



Question 1 continued

(Total for Question 1 is 4 marks)



2. Jamie takes out an interest-free loan of £8100

Jamie makes a payment every month to pay back the loan.

Jamie repays £400 in month 1, £390 in month 2, £380 in month 3, and so on, so that the amounts repaid each month form an arithmetic sequence.

(a) Show that Jamie repays £290 in month 12

(1)

After Jamie's N th payment, the loan is completely paid back.

(b) Show that $N^2 - 81N + 1620 = 0$

(2)

(c) Hence find the value of N .

(2)

Question 2 continued

(Total for Question 2 is 5 marks)











Question 13 continued

(Total for Question 13 is 7 marks)



3. The first three terms of an arithmetic sequence are

$6k, 10$ and $2k$

where k is a constant.

(a) Find the value of k .

(2)

(b) Hence find the value of the sum of the first 50 terms of this sequence.

(3)





SUB-TOPIC 4.5

GEOMETRIC SEQUENCES AND SERIES

Sub-topic 4.5 · 5 questions · 37 marks · lowest tariff first



5.

In this question you should show all stages of your working.

Solutions relying entirely on calculator technology are not acceptable.

A company made a profit of £20 000 in its first year of trading, Year 1

A model for future trading predicts that the yearly profit will increase by 8% each year, so that the yearly profits will form a geometric sequence.

According to the model,

- (a) show that the profit for Year 3 will be £23 328 (1)
- (b) find the first year when the yearly profit will exceed £65 000 (3)
- (c) find the total profit for the first 20 years of trading, giving your answer to the nearest £1000 (2)



Question 5 continued

(Total for Question 5 is 6 marks)



9. The first 3 terms of a geometric sequence are

$$3^{4k-5} \quad 9^{7-2k} \quad 3^{2(k-1)}$$

where k is a constant.

(a) Using algebra and making your reasoning clear, prove that $k = \frac{5}{2}$ (3)

(b) Hence find the sum to infinity of the geometric sequence. (3)





15.

In this question you must show all stages of your working.

Solutions relying entirely on calculator technology are not acceptable.

A geometric series has common ratio r and first term a .

Given $r \neq 1$ and $a \neq 0$

(a) prove that

$$S_n = \frac{a(1-r^n)}{1-r} \quad (4)$$

Given also that S_{10} is four times S_5

(b) find the exact value of r . (4)

Question 15 continued

Question 15 continued

(Total for Question 15 is 8 marks)



15.

In this question you must show all stages of your working.

Solutions relying on calculator technology are not acceptable.

Given that the first three terms of a geometric series are

$$12 \cos \theta \qquad 5 + 2 \sin \theta \qquad \text{and} \qquad 6 \tan \theta$$

(a) show that

$$4 \sin^2 \theta - 52 \sin \theta + 25 = 0 \quad (3)$$

Given that θ is an obtuse angle measured in radians,

(b) solve the equation in part (a) to find the exact value of θ

(c) show that the sum to infinity of the series can be expressed in the form

$$k(1 - \sqrt{3})$$

where k is a constant to be found. (5)



Question 15 continued

Lined area for writing the answer to Question 15.

Question 15 continued

Lined area for writing the answer to Question 15.

(Total for Question 15 is 10 marks)



SUB-TOPIC 4.6

SEQUENCES AND SERIES IN MODELLING

Sub-topic 4.6 · 1 question · 6 marks · lowest tariff first



Question 5 continued

(Total for Question 5 is 6 marks)



MARK SCHEMES

official mark schemes



Question	Scheme	Marks	AOs
1(a)	$16 + (21-1) \times d = 24 \Rightarrow d = \dots$	M1	1.1b
	$d = 0.4$	A1	1.1b
	Answer only scores both marks.		
		(2)	
(b)	$S_n = \frac{1}{2}n\{2a + (n-1)d\} \Rightarrow S_{500} = \frac{1}{2} \times 500 \{2 \times 16 + 499 \times "0.4"\}$	M1	1.1b
	$= 57\,900$	A1	1.1b
	Answer only scores both marks		
		(2)	
	(b) Alternative using $S_n = \frac{1}{2}n\{a + l\}$		
	$l = 16 + (500-1) \times "0.4" = 215.6 \Rightarrow S_{500} = \frac{1}{2} \times 500 \{16 + "215.6"\}$	M1	1.1b
	$= 57\,900$	A1	1.1b
(4 marks)			
Notes			
(a) M1: Correct strategy to find the common difference – must be a correct method using $a = 16$, and $n = 21$ and the 24. The method may be implied by their working. If the AP term formula is quoted it must be correct, so use of e.g. $u_n = a + nd$ scores M0 A1: Correct value. Accept equivalents e.g. $\frac{8}{20}, \frac{4}{10}, \frac{2}{5}$ etc. (b) M1: Attempts to use a correct sum formula with $a = 16$, $n = 500$ and their numerical d from part (a) If a formula is quoted it must be correct (it is in the formula book) A1: Correct value Alternative: M1: Correct method for the 500th term and then uses $S_n = \frac{1}{2}n\{a + l\}$ with their l A1: Correct value Note that some candidates are showing implied use of $u_n = a + nd$ by showing the following: (a) $d = \frac{24-16}{21} = \frac{8}{21}$ (b) $S_{500} = \frac{1}{2} \times 500 \left\{ 2 \times 16 + 499 \times \frac{8}{21} \right\} = 55523.80952\dots$ This scores (a) M0A0 (b) M1A0			

Question	Scheme	Marks	AOs
2(a)	$(u_{12} =) 400 + 11 \times -10 = 290^*$ or e.g. $(u_{12} =) 400 - 110 = 290^*$ or e.g. $(u_{12} =) 400 + (12 - 1) \times -10 = 290^*$ or e.g. $(u_{12} =) 410 + 12 \times -10 = 290^*$	B1*	1.1b
		(1)	
	Alternative 1:		
	$400 + (n - 1) \times -10 = 290$ $\Rightarrow 400 - 10n + 10 = 290 \Rightarrow 10n = 120 \Rightarrow n = 12^*$	B1*	1.1b
	Alternative 2:		
	$290 = 400 + (12 - 1)d \Rightarrow 11d = -110 \Rightarrow d = -10^*$	B1*	1.1b
(b)	$8100 = \frac{1}{2} N (2 \times 400 + (N - 1) \times -10)$ or e.g. $8100 = \frac{1}{2} N (400 + 400 + (N - 1) \times -10)$	M1	1.1b
	$8100 = \frac{1}{2} N (2 \times 400 + (N - 1) \times -10)$ $\Rightarrow 16200 = 800N - 10N^2 + 10N$ or e.g. $\Rightarrow 8100 = 400N - 5N^2 + 5N$ $\Rightarrow N^2 - 81N + 1620 = 0^*$	A1*	2.1
		(2)	
(c)	$N^2 - 81N + 1620 = 0 \Rightarrow (N - 45)(N - 36) = 0 \Rightarrow N = 45, 36$	M1	1.1b
	$(N =) 36$	A1	2.3
		(2)	
(5 marks)			
Notes			
(a) B1*: Correct working to obtain 290. Must be a correct calculation so do not condone missing brackets unless they are recovered. E.g. $(u_{12} =) 400 + 12 - 1 \times -10 = 290$ scores B0 unless followed by $= 400 + 11 \times -10 = 290$. Condone $(u_{12} =) 400 + (12 - 1) - 10 = 290$. The “£” symbol is not required but the “290” must appear. Alternative 1: B1*: Correct working using the 290 to obtain $n = 12$. There must be at least one intermediate line after setting up the equation and must be correct work so do not condone missing brackets unless they are recovered (as above). A conclusion is not required with this approach as long as 12 is correctly obtained. Alternative 2: B1*: Correct working using the 290 and 400 to obtain $d = -10$. There must be at least one intermediate line after setting up the equation and must be correct work so do not condone missing brackets unless they are recovered (as above). A conclusion is not required with this approach as long as -10 is correctly obtained. Allow candidates to list terms and show the 12th term is 290 e.g. 400, 390, 380, 370, 360, 350, 340, 330, 320, 310, 300, 290 Must list all 12 terms which must be correct and end with 290 Condone if missing 400, 390, 380 as these are given in the question. (b) Mark (b) and (c) together			



M1: Uses a correct sum formula in terms of N or n with $a = 400$ and $d = -10$ or $+10$ and sets $= 8100$. Condone e.g. > 8100 and allow A1 if this is recovered to become “=” before the final line.

Condone $8100 = \frac{1}{2}N(2 \times 400 + (N-1)-10)$ if recovered or not.

A1*: Fully correct proof with sufficient working shown and no unrecovered errors. Do not condone e.g. missing brackets or e.g. a missing N/n unless recovered before the final given answer.

Condone the use of n instead of N for **both** marks.

Condone terms in a different order as long as they are correct.

Condone $0 = N^2 - 81N + 1620$ *

Sufficient working requires all brackets to be removed to obtain an unsimplified expanded quadratic before proceeding to the given answer including the “=0”.

Alternative (further maths method): Series summation approach:

$$\sum_{r=1}^N (410 - 10r) = 8100 \Rightarrow 410N - 10 \times \frac{1}{2}N(N+1)$$

$$\Rightarrow 410N - 5N^2 - 5N = 8100 \Rightarrow N^2 - 81N + 1620 = 0^*$$

M1: Attempt to sum an appropriate series with first term 400. Condone use of $+10$ as in the main scheme.

A1*: As main scheme.

(c)

M1: Solves the **given** quadratic equation by any correct method including a calculator to obtain at least one value for N . See general guidance for solving a 3-term quadratic.

If values are just written down and only one value is given it must be 45 or 36.

If both values are just written down they must both be correct.

A1: Realises that the smaller value is required and so selects ($N =$) 36.

Ignore any units if given.

The “ $N =$ ” is not required, just look for the correct value.

It must be clear that this value has been selected. This may be indicated by e.g. underlining the 36 or the omission of the 45. If the 45 is not rejected score A0.

$N = 36$ with no working scores M1A1

Question	Scheme	Marks	AOs
8(a)	$R = \sqrt{2^2 + 8^2} = \sqrt{68} = 2\sqrt{17}$	B1	1.1b
	$2 \cos \theta + 8 \sin \theta = R \cos \theta \cos \alpha + R \sin \theta \sin \alpha$ $2 = R \cos \alpha \quad 8 = R \sin \alpha$ $\tan \alpha = \frac{8}{2} \Rightarrow \alpha = \dots$	M1	1.1b
	$\alpha = \text{awrt } 1.326$	A1	2.2a
		(3)	
(b)(i)	$4.5 \times "2\sqrt{17}"$	M1	1.1b
	$9\sqrt{17}$	A1	2.2a
(ii)	$\text{awrt } 1.33$	B1ft	2.2a
		(3)	
(6 marks)			
Notes			
(a) B1: $R = 2\sqrt{17}$ or $\sqrt{68}$. $\pm 2\sqrt{17}$ or $\pm\sqrt{68}$ score B0 (Condone if this comes from e.g., $8 = R \cos \alpha \quad 2 = R \sin \alpha$) Decimal answers score B0 unless the exact value is seen then apply isw. M1: Proceeds to a value for α from $\tan \alpha = \pm \frac{8}{2}$, $\cos \alpha = \pm \frac{2}{\sqrt{68}}$, $\sin \alpha = \pm \frac{8}{\sqrt{68}}$ May be implied by awrt 1.33 radians or 76 degrees A1: awrt 1.326 for α. Apply isw if this is then subsequently rounded to e.g. 1.33			
(b)(i) M1: For a value of $\pm 4.5 \times$ their R or allow $\pm 4.5R$ (with the letter R) But not embedded in an expression e.g. $9\sqrt{17} \cos(\theta - \alpha)$ unless extracted later. Note that the sum may be found as $9 \cos x + 36 \sin x$ with the maximum then found using calculus e.g. $S = 9 \cos x + 36 \sin x \Rightarrow \frac{dS}{dx} = -9 \sin x + 36 \cos x = 0 \Rightarrow \tan x = 4 \Rightarrow \sin x = \frac{4}{\sqrt{17}}$, $\cos x = \frac{1}{\sqrt{17}}$ $\Rightarrow 9 \cos x + 36 \sin x = 9\sqrt{17}$. This will score M1 once they reach $\pm 4.5 \times$ their R May be implied by $9\sqrt{17}$ or awrt 37.1 (which may come from a graphical method) May also see e.g. $\text{Max}(9 \cos x + 36 \sin x) = \sqrt{9^2 + 36^2} = \dots$ A1: $9\sqrt{17}$ or exact equivalent e.g. $\sqrt{1377}$, $4.5\sqrt{68}$, $4.5(2\sqrt{17})$ and apply isw once a correct answer is seen			
(ii) B1ft: awrt 1.33 (or follow through on their α even if in degrees (76), no matter how accurate)			

Question	Scheme	Marks	AOs
13 (i)	States that $S = a + (a + d) + \dots + (a + (n - 1)d)$	B1	1.1a
	$S = a + \dots + (a + d) + \dots + (a + (n - 1)d)$ $S = (a + (n - 1)d) + (a + (n - 2)d) + \dots + a$	M1	3.1a
	Reaches $2S = n \times (2a + (n - 1)d)$ And so proves that $S = \frac{n}{2}[2a + (n - 1)d]$ *	A1*	2.1
		(3)	
(ii)	(a) $S = 10 + 9.20 + 8.40 + \dots$		
	$64 = \frac{n}{2}(20 - 0.8(n - 1))$ o.e	M1	3.1b
	$128 = 20n - 0.8n^2 + 0.8n$ $0.8n^2 - 20.8n + 128 = 0$ $n^2 - 26n + 160 = 0$ *	A1*	2.1
		(2)	
	(b) $n = 10, 16$	B1	1.1b
		(1)	
	(c) 10 weeks with a minimal correct reason. E.g. - He has saved up the amount by 10 weeks so he would not save for another 6 weeks - You would choose the smaller number - He starts saving negative amounts (in week 14) so 16 does not make sense	B1	2.3
		(1)	
(7 marks)			
Notes:			

(i)

B1: Correctly writes down an expression for the key terms S or S_n including $S =$ or $S_n =$

Allow a minimum of 3 correct terms including the first and last terms, and no incorrect terms.

Score for S or $S_n = a + (a + d) + \dots + (a + (n - 1)d)$ with + signs, not commas

If the series contains extra terms that should not be there E.g

 $S = a + (a + d) + \dots + (a + nd) + (a + (n - 1)d)$ score B0**M1:** For the key step in reversing the terms and adding the two series.Look for a minimum of two terms, including a and $a + (n - 1)d$, the series reversed with evidence of adding, for example $2S =$ Condone the extra incorrect terms (see above) appearing.

Can be scored when terms are separated by commas

A1*: Shows correct work (no errors) with all steps shown leading to given answer.

There should be no incorrect terms. A minimum of 3 terms should be shown in each sum



The solution below is a variation of this.

$$S = a + (a + d) + \dots + l$$

$$S = l + (l - d) + \dots + a$$

$$2S = n(a + l)$$

$$S = \frac{n}{2}(a + l) = \frac{n}{2}(a + a + (n-1)d) = \frac{n}{2}(2a + (n-1)d)$$

B1 and A1 are not scored until the last line, M scored on line 3

The following scores B1 M0 A0 as the terms in the second sum are not reversed

Handwritten student work for the sum of an arithmetic series:

$$\begin{aligned}
 (i) \quad S_n &= a + (a + d) + (a + 2d) \dots a + (n-1)d \\
 &+ \\
 S_n &= \cancel{a} + \cancel{(a + d)} + \dots + \cancel{(a + (n-1)d)} + a + (n-2)d + \dots + (a + d) + \cancel{a} \\
 &= \\
 2S_n &= 2a + \cancel{(n-1)d} + \cancel{2a + (n-1)d} + \dots + \cancel{2a + (n-1)d} + \cancel{(n-1)d} \\
 2S_n &= n[2a + (n-1)d]
 \end{aligned}$$

SC in (a) Scores B1 M0 A0.

They use $0 + 1 + 2 + \dots + (n-1) = \frac{n(n-1)}{2}$ which relies on the quoted proof.

Handwritten student work for the sum of an arithmetic series:

$$\begin{aligned}
 (i) \quad S_n &= a + (a + d) + (a + 2d) \dots a + (n-1)d \\
 S_n &= a + a + d + a + 2d + \dots + a + (n-1)d \\
 S_n &= an + (0 + 1 + 2 + 3 + \dots + n-1)d \\
 \text{sum of } 1 \text{ to } n-1 &= \frac{n(n-1)}{2} \\
 S_n &= an + \frac{n(n-1)}{2}d \\
 S_n &= n(a + \frac{(n-1)d}{2}) \\
 S_n &= \frac{n}{2}(2a + (n-1)d)
 \end{aligned}$$

(ii) (a)

M1: Uses the information given to set up a correct equation in n .

The values of S , a and d need to be correct and used within a correct formula

Possible ways to score this include unsimplified versions $64 = \frac{n}{2}(2 \times 10 + (n-1) \times -0.8)$,

$64 = \frac{n}{2}(10 + 10 + (n-1) \times -0.8)$ or versions using pence rather than £'s $6400 = \frac{n}{2}(2000 + (n-1) \times -80)$

Allow recovery for both marks following $64 = \frac{n}{2}(2 \times 10 + (n-1) \times -0.8)$ with an invisible $\times$

A1*: Proceeds without error to the given answer. (Do not penalise a missing final trailing bracket)

Look for at least a line with the brackets correctly removed as well as a line with the terms in n correctly combined

E.g. $64 = \frac{n}{2}(20 + (n-1) \times -0.8) \Rightarrow 64 = 10n - 0.4n^2 + 0.4n \Rightarrow 0.4n^2 - 10.4n + 64 = 0 \Rightarrow n^2 - 26n + 160 = 0$

(ii)(b)

B1: $n = 10, 16$

(ii)(c)

B1: Chooses 10 (weeks) and gives a minimal acceptable reason. The reason must focus on why the answer is 10 (weeks) rather than 16 (weeks) or alternatively why it would not be 16 weeks

Question	Scheme	Marks	AOs
3 (a)	Attempts to solve $10 - 6k = 2k - 10 \Rightarrow k = \dots$	M1	3.1a
	$\left(k = \right) \frac{5}{2}$ o.e.	A1	1.1b
		(2)	
(b)	Deduces the value of "d" = -5	B1 ft	2.2a
	$S_{50} = \frac{50}{2} \left(2 \times "15" + 49 \times "-5" \right)$	M1	1.1b
	= - 5375	A1	1.1b
		(3)	

(5 marks)

Notes:**(a) Condone using other letters for a and d (e.g. may use r for d)**

M1: Attempts a valid method to solve the problem

- Uses the common difference to form a correct equation and attempts to solve to find a value for k
e.g. Attempts to solve $10 - 6k = 2k - 10$ o.e such as $2k - 6k = 2(10 - 6k)$
- Uses 10 as the mean of $2k$ and $6k$: $\frac{2k + 6k}{2} = 10 \Rightarrow k = \dots$
- Sets up correct equations $a = 6k$, $a + d = 10$ and $a + 2d = 2k$, or may be seen as $6k + d = 10$ and $10 + d = 2k$, **and** proceeds to find k .
- Uses the summation formula $S_3 = \frac{3}{2}(6k + 2k) = 6k + 10 + 2k$ **and** proceeds to find k

In each attempt the initial equation (or simultaneous equations) must be correct but do not be concerned by the mechanics of the rearrangement to find k . May be implied by $k = \frac{5}{2}$

A1: $\left(k = \right) \frac{5}{2}$ o.e.**(b) Work seen in (a) can only be scored if seen or used in (b)**

B1ft: Common difference = -5 **or** ft on their value for k (even if k has been found from an incorrect method) e.g. $10 - 6 \times \frac{5}{2}$ or e.g. $2 \times \frac{5}{2} - 10$ if only a numerical value is seen.
May be implied or seen in a term or summation formula.

Note that some candidates may work in terms of k throughout so only allow B1ft to be scored when they substitute in their numerical value for k , following $10 - 6k$ o.e. correctly embedded in a correct formula. They may make arithmetical slips before they substitute in their numerical value for k which can be condoned.



M1: Attempts to use a **correct formula**. The expression is sufficient to score this mark but they must be using a correct value for a and $\pm d$ (or fit on their value for k for a and d) which are correctly placed in the formula.

$$\text{e.g. } \left(S_{50} = \right) \frac{50}{2} \left(2 \times "6k" + 49 \times "\pm d" \right).$$

Alternatively, they may find the 50th term $u_{50} = "15" + (50 - 1) \times "-5" = -230$ and use

$$\left(S_{50} = \right) \frac{50}{2} \left("15" + "-230" \right).$$

If working in terms of k they must substitute in their value for k

$$\text{e.g. } \left(S_{50} = \right) \frac{50}{2} \left(2 \times 6k + 49 \times (10 - 6k) \right) = -7050k + 12250 = -7050 \times "\frac{5}{2}" + 12250$$

Do not withhold this mark for omission of brackets around (-5)

$$\text{e.g. } \frac{50}{2} \left(2 \times 15 + (49) - 5 \right) \text{ scores M1}$$

A1: – 5375 cao



Question	Scheme	Marks	AOs
5(a)	$u_3 = £20\,000 \times 1.08^2 = (£) 23\,328^*$	B1*	1.1b
		(1)	
(b)	$20\,000 \times 1.08^{n-1} > 65\,000$	M1	1.1b
	$1.08^{n-1} > \frac{13}{4} \Rightarrow n-1 > \frac{\ln(3.25)}{\ln(1.08)}$ or e.g. $1.08^{n-1} > \frac{13}{4} \Rightarrow n-1 > \log_{1.08}\left(\frac{13}{4}\right)$	M1	3.1b
	Year 17	A1	3.2a
		(3)	
(c)	$S_{20} = \frac{20\,000(1-1.08^{20})}{1-1.08}$	M1	3.4
	Awt (£) 915 000	A1	1.1b
		(2)	
(6 marks)			
Notes			

(a)

B1*: Uses a correct method to show that the Profit in Year 3 will be £23 328. Condone missing units

E.g. $£20\,000 \times 1.08^2$ or $£20\,000 \times 108\% \times 108\%$

This may be obtained in two steps. E.g. $\frac{8}{100} \times 20\,000 = 1600$ followed by $\frac{8}{100} \times 21\,600 = 1728$ with the calculations $21\,600 + 1728 = 23\,328$ seen.

Condone calculations seen as 8% of $20\,000 = 1600$.

This is a show that question and the method must be seen.

It is not enough to state Year 1 = £21 600, Year 2 = £ 23 328



(b)

M1: Sets up an inequality or an equation that will allow the problem to be solved.

Allow for example N or n for $n - 1$. So award for $20\,000 \times 1.08^{n-1} > 65\,000$,

$20\,000 \times 1.08^n = 65\,000$ or $20\,000 \times (108\%)^n \geq 65\,000$ amongst others.

Condone **slips** on the 20 000 and 65 000 but the 1.08 o.e. must be correct

M1: Uses a correct strategy involving logs in an attempt to solve a type of equation or inequality of the form seen above. It cannot be awarded from a sum formula

The equation/inequality must contain an index of $n - 1$, N , n etc.

Again condone **slips** on the 20 000 and 65 000 but additionally condone an error on the 1.08, which may appear as 1.8 for example

$$\text{E.g. } 20\,000 \times 1.08^n = 65\,000 \Rightarrow n \log 1.08 = \log \frac{65\,000}{20\,000} \Rightarrow n = \dots$$

$$\text{E.g. } 20\,000 \times 1.8^n = 65\,000 \Rightarrow \log 20\,000 + n \log 1.8 = \log 65\,000 \Rightarrow n = \dots$$

A1: Interprets their decimal value and gives the correct year number. Year 17

The demand of the question dictates that solutions relying entirely on calculator technology are not acceptable, BUT allow a solution that appreciates a **correct term** formula or the entire set of calculations where you may see the numbers as part of a larger list

E.g. Uses, or implies the use of, an acceptable calculation and finds value(s)

for M1: $(n = 16) \Rightarrow P = 20\,000 \times 1.08^{15} = \text{awrt } 63\,400$ or $(n = 17) \Rightarrow P = 20\,000 \times 1.08^{16} = \text{awrt } 68\,500$

M1: $(n = 16) \Rightarrow P = 20\,000 \times 1.08^{15} = \text{awrt } 63\,400$ and $(n = 17) \Rightarrow P = 20\,000 \times 1.08^{16} = \text{awrt } 68\,500$

A1: 17 years following correct method and both M's

(c)

M1: Attempts to use the model with a **correct** sum formula to find the total profit for the 20 years.

You may see an attempt to find the sum of 20 terms via a list. This is acceptable provided there are 20 terms with $u_n = 1.08 \times u_{n-1}$ seen at least 4 times and the sum attempted.

Condone a slip on the 20 000 (e.g appearing as 2 000) and/or a slip on the 1.08 with it being the same "r" as in (b). Do not condone 20 appearing as 19 for instance

A1: awrt £915 000 but condone missing unit

The demand of the question dictates that all stages of working should be seen. An answer without working scores M0 A0

Question	Scheme	Marks	AOs
9(a)	$\frac{9^{7-2k}}{3^{4k-5}} = \frac{3^{2(k-1)}}{9^{7-2k}} \Rightarrow \frac{3^{2(7-2k)}}{3^{4k-5}} = \frac{3^{2(k-1)}}{3^{2(7-2k)}}$	M1	3.1a
	$(3^{2(7-2k)})^2 = 3^{4k-5} \times 3^{2(k-1)}$ $\Rightarrow 28-8k = 6k-7 \Rightarrow k = \dots$	dM1	1.1b
	$k = \frac{5}{2}^*$	A1*	2.1
		(3)	
(b)	$a = 3^{4(2.5)-5}$ and $r = \frac{9^{7-2(2.5)}}{3^{4(2.5)-5}} \Rightarrow$ one of $a = 243$ or $r = \frac{1}{3}$	M1	2.2a
	$S_{\infty} = \frac{a}{1-r} = \frac{"243"}{1-"1/3"}$	M1	1.1b
	$S_{\infty} = \frac{729}{2} (364.5)$ cao	A1	1.1b
		(3)	
(6 marks)			
Notes			
(a) Special cases: SC 1: For those that verify rather than prove a SC 100 is awarded for substituting $k = \frac{5}{2}$ into all three terms to correctly obtain 243, 81 and 27 with a statement that this is geometric with $r = \frac{1}{3}$ (or equivalent reason). All statements must be correct. SC 2: Be aware that e.g. $\frac{9^{7-2k}}{3^{4k-5}} = \frac{3^{2(k-1)}}{9^{7-2k}} \Rightarrow 81^{2(7-2k)} = 9^{6k-7}$ is an incorrect process (without some indication that they have intentionally squared both sides) that fortuitously leads to the correct answer and may score maximum SC 010. M1: Uses the 3 terms to set up an equation in k and either reaches a common base by replacing 9 with 3^2 or by replacing 3 with $9^{0.5}$ and uses the power law of indices correctly or uses the laws of indices correctly to reach $9^{14-4k} = 3^{6k-7}$ condoning slips in e.g. expanding brackets. Writing down e.g. $2(7-2k) - (4k-5) = 2(k-1) - 2(7-2k)$ is sufficient to imply the M1. dM1: Correct processing leading to a value for k. A1*: Correct value following correct working. Allow $k = 2.5$ in place of $k = \frac{5}{2}$ Condone missing/invisible brackets provided they are recovered correctly. Alt 1 Using Base 9: $\frac{9^{7-2k}}{3^{4k-5}} = \frac{3^{2(k-1)}}{9^{7-2k}} \Rightarrow \frac{9^{7-2k}}{9^{2k-2.5}} = \frac{9^{k-1}}{9^{7-2k}} \text{ o.e. scores M1}$ $\Rightarrow 9^{9.5-4k} = 9^{3k-8} \Rightarrow 9.5-4k = 3k-8 \Rightarrow 7k = 17.5 \Rightarrow k = 2.5$ Score dM1 when a value of k is achieved using a correct process and A1* if fully correct.			

Alt 2 Finding r in terms of k and using e.g. $u_3 = ar^2$:

$$r = \frac{9^{7-2k}}{3^{4k-5}} = \frac{3^{2(7-2k)}}{3^{4k-5}} = \{3^{19-8k}\} \text{ or } r = \frac{3^{2(k-1)}}{9^{7-2k}} = \frac{3^{2k-2}}{3^{2(7-2k)}} = \{3^{6k-16}\}$$

$$\Rightarrow 3^{4k-5} \times (3^{19-8k})^2 = 3^{2k-2} \text{ or } \Rightarrow 3^{4k-5} \times (3^{6k-16})^2 = 3^{2k-2} \text{ scores M1}$$

$$\Rightarrow 3^{4k-5} \times 3^{2(19-8k)} = 3^{2k-2} \Rightarrow 33-12k = 2k-2 \Rightarrow 14k = 35 \Rightarrow k = 2.5$$

Score dM1 when a value of k is achieved using a correct process and A1* if fully correct.

Alt 3 Using Logs Way 1:

$$\frac{9^{7-2k}}{3^{4k-5}} = \frac{3^{2(k-1)}}{9^{7-2k}} \Rightarrow (9^{7-2k})^2 = 3^{6k-7} \Rightarrow 9^{14-4k} = 3^{6k-7} \text{ scores M1}$$

$$\Rightarrow (14-4k)\log_3 9 = 6k-7$$

$$\Rightarrow 2(14-4k) = 6k-7$$

$$\Rightarrow k = 2.5$$

Score dM1 when a value of k is achieved using a correct process and A1* if fully correct.

Alt 4 Using Logs Way 2:

$$\frac{9^{7-2k}}{3^{4k-5}} = \frac{3^{2(k-1)}}{9^{7-2k}}$$

$$\Rightarrow (7-2k)\log_3 9 - (4k-5)\log_3 3 = (2k-2)\log_3 3 - (7-2k)\log_3 9 \text{ scores M1}$$

$$\Rightarrow 2(7-2k) - (4k-5) = 2k-2 - 2(7-2k)$$

$$\Rightarrow 19-8k = 6k-16$$

$$\Rightarrow k = 2.5$$

Score dM1 when a value of k is achieved using a correct process and A1* if fully correct.

Alt 5 Recognising that taking $\log_3$ forms an Arithmetic Sequence:

$$\{\log_3\}u_1 = 4k-5, \{\log_3\}u_2 = 2(7-2k), \{\log_3\}u_3 = 2(k-1)$$

$$\Rightarrow 2(7-2k) - (4k-5) = 2(k-1) - 2(7-2k) \text{ scores M1}$$

$$\Rightarrow 19-8k = 6k-16$$

$$\Rightarrow k = 2.5$$

Score dM1 when a value of k is achieved using a correct process and A1* if fully correct.
There is no need to see any mention of log in this approach.

(b)

M1: Deduces expressions for the first term **and** the common ratio using $k = \frac{5}{2}$ in the correct formulae **and** finds at least one of $a = 243$ or $r = \frac{1}{3}$. Allow if seen in (a). May be implied by

correct values for a and r . For reference, $a = 3^{4(2.5)-5}$ and $r = \frac{9^{7-2(2.5)}}{3^{4(2.5)-5}} \left\{ \text{or } r = \frac{3^{2(2.5-1)}}{9^{7-2(2.5)}} \right\}$

M1: Recalls the sum to infinity formula and substitutes their values for a and r provided $|r| < 1$
Dependent on a correct attempt to find both a and r using $k = 2.5$ but allow if neither value is correct or if they are unprocessed e.g. $\frac{3^{4(2.5)-5}}{1 - \frac{9^{7-2(2.5)}}{3^{4(2.5)-5}}}$ scores this mark.

A1: cao. Correct sum to infinity. Answer only (with no working) scores full marks. Apply isw.

Question	Scheme	Marks	AOs
9(a)	$\frac{12-3k}{3k+4} = \frac{k+16}{12-3k}$	M1	3.1a
	$3k^2 - 62k + 40 = 0$ *	A1*	1.1b
		(2)	
(b)(i)	$3k^2 - 62k + 40 = 0 \Rightarrow k = \dots$	M1	1.1b
	States $k = 20$ and gives a reason e.g. that this gives a values of r such that $ r < 1$	A1	3.2a
	$a = 64$ and $r = -\frac{3}{4}$ (or allow $a = 6$ and $r = \frac{5}{3}$)	B1	1.1b
	$S_{\infty} = \frac{"64"}{1 - "(-\frac{3}{4})"} = \dots$	M1	3.1a
	$S_{\infty} = \frac{256}{7}$	A1	1.1b
		(5)	
(7 marks)			
Notes			
(a) M1: Forms a correct equation linking the three terms. Condone invisible brackets if implied by further work. Possible equations below (which are not exhaustive) should use nth term or sum of series formulae e.g. $\frac{12-3k}{3k+4} = \frac{k+16}{12-3k}$ or $\left(\frac{12-3k}{3k+4}\right)^2 = \frac{k+16}{3k+4}$ or $(12-3k)^2 = (3k+4)(k+16)$ or $(3k+4)\left(\frac{k+16}{12-3k}\right) = 12-3k$ or $(12-3k)\left(\frac{12-3k}{k+16}\right) = 3k+4$ or $3k+4+12-3k+k+16 = \frac{(3k+4)\left(1-\left(\frac{k+16}{12-3k}\right)^3\right)}{1-\frac{k+16}{12-3k}}$ (sum of three terms) A1*: Achieves the given quadratic with no errors including invisible brackets. It cannot be for just proceeding in one step from the starting equation to the given answer and usually will involve attempting to multiply out brackets or dealing with any fractions.			
(b)(i) M1: Attempts to solve the given quadratic achieving at least one value for k. Usual rules apply for solving a quadratic and this may be achieved directly from a calculator. (May also be implied by $\frac{2}{3}$)			

- A1: 20 and gives correct reasoning (**if r is found anywhere in part (i) then it must be correct**):
 e.g. 20 since $|r| < 1$. e.g. since $|r| = 0.75 < 1$
 e.g. by listing **at least two consecutive** terms for $k = 20$ (must be correct) e.g. 64, -48 do not withhold this mark if they proceed to make a comment e.g. “the numbers are getting smaller” as we are condoning this to mean they are referring to the magnitude of the numbers
 e.g. when $k = 20$, $r = -\frac{3}{4}$ o.e. which is between 1 and -1 (condone “it is smaller than 1”).
 Do not accept a reason on its own which is just simply stating that the sequence is converging or equivalent such as “spiralling”.
 Allow reasoning which excludes $k = \frac{2}{3}$ e.g. $r = \frac{5}{3}$ which is greater than 1.

(ii)

Work may be seen in part (i), but must be used in part (ii) to score.

- B1: $a = 64$ and $r = -\frac{3}{4}$ o.e. (or allow $a = 6$ and $r = \frac{5}{3}$ o.e.) May be implied by later work or a correct calculation using these values to find S_{∞}

- M1: A full attempt to find S_{∞} by using their value of k to reach a value for r such that $|r| < 1$ and a value for a . Condone sign slips in their calculations of a and r only. You may need to check this by substituting in their value for k if no calculations are seen.

They must substitute these values in to $\frac{a}{1-r}$ correctly so e.g. $a = 64$, $r = -\frac{3}{4} \Rightarrow S_{\infty} = \frac{64}{1 - \frac{3}{4}}$ is M0.

They cannot just substitute in their k as r in the formula.

Do not allow attempts to manually calculate the values of lots of terms for this mark as this would not lead to the answer. $\sum_{n=1}^{\infty} 64 \times \left(-\frac{3}{4}\right)^{n-1}$ on its own is M0.

- A1: $\frac{256}{7}$ cao. (Do not allow 36.6 as this is not S_{∞}) isw after a correct exact answer is seen.



Question	Scheme	Marks	AOs
15(a)	$S_n = a + ar + ar^2 + \dots + ar^{n-1}$	B1	1.2
	$rS_n = ar + ar^2 + ar^3 + \dots + ar^n \Rightarrow S_n - rS_n = \dots$	M1	2.1
	$S_n - rS_n = a - ar^n$	A1	1.1b



	$S_n(1-r) = a(1-r^n) \Rightarrow S_n = \frac{a(1-r^n)}{(1-r)}^*$	A1*	2.1
		(4)	
(b)	$\frac{a(1-r^{10})}{1-r} = 4 \times \frac{a(1-r^5)}{1-r} \text{ or } 4 \times \frac{a(1-r^{10})}{1-r} = \frac{a(1-r^5)}{1-r}$ Equation in r^{10} and r^5 (and possibly $1-r$)	M1	3.1a
	$1-r^{10} = 4(1-r^5)$	A1	1.1b
	$r^{10} - 4r^5 + 3 = 0 \Rightarrow (r^5 - 1)(r^5 - 3) = 0 \Rightarrow r^5 = \dots$ or e.g. $1-r^{10} = 4(1-r^5) \Rightarrow (1-r^5)(1+r^5) = 4(1-r^5) \Rightarrow r^5 = \dots$	dM1	2.1
	$r = \sqrt[5]{3} \text{ oe only}$	A1	1.1b
		(4)	
(8 marks)			

Notes:

(a)

B1: Writes out the sum or lists terms. Condone the omission of S .

The sum must include the first and last terms and (at least) two other correct terms and no incorrect terms e.g. ar^n

Note that the sum may be seen embedded within their working.

M1: For the key step in attempting to multiply the first series by r and subtracting.

A1: $S_n - rS_n = a - ar^n$ either way around but condone one side being prematurely factorised (but not both)

following correct work but this could follow B0 if insufficient terms were shown.

A1*: Depends on all previous marks. Proceeds to given result showing all steps including seeing both sides unfactorised at some point in their working.

Note: If terms are listed rather than added then allow the first 3 marks if otherwise correct but withhold the final mark.

(b)

M1: For the correct strategy of producing an equation in just r^{10} and r^5 (and possibly $(1-r)$) with the “4” on either side using the result from part (a) and makes progress to at least cancel through by a

Some candidates retain the “ $1-r$ ” and start multiplying out e.g. $(1-r)(1-r^{10})$ and this mark is still available as long as there is progress in cancelling the “ a ”.

A1: Correct equation with the a and the $1-r$ cancelled. Allow any correct equation in just r^5 and r^{10}

dM1: Depends on the first M. Solves as far as $r^5 = \dots$ by solving a 3 term quadratic in r^5 by a valid method – see general guidance or by difference of 2 squares – see above

A1: $r = \sqrt[5]{3}$ oe only. The solution $r = 1$ if found must be rejected here.

(b) Note: For candidates who use $S_5 = 4S_{10}$ expect to see:

$$4 \times \frac{a(1-r^{10})}{1-r} = \frac{a(1-r^5)}{1-r} \Rightarrow 4(1-r^{10}) = (1-r^5) \text{ M1A0}$$

Example for (a): $4r^{10} - 3 = 0 \Rightarrow (4r^5 + 3)(r^5 - 1) = 0 \Rightarrow r^5 = \dots$ or $4(1-r^5)(1+r^5) = (1-r^5) \Rightarrow r^5 = \dots$ dM1A0



Question	Scheme	Marks	AOs
15(a)	Uses the common ratio $\frac{5+2\sin\theta}{12\cos\theta} = \frac{6\tan\theta}{5+2\sin\theta}$ o.e.	M1	3.1a
	Cross multiplies and uses $\tan\theta \times \cos\theta = \sin\theta$ $(5+2\sin\theta)^2 = 6 \times 12 \sin\theta$	dM1	1.1b
	Proceeds to given answer $25 + 20\sin\theta + 4\sin^2\theta = 72\sin\theta$ $\Rightarrow 4\sin^2\theta - 52\sin\theta + 25 = 0$ *	A1*	2.1
		(3)	
(a) Alt	(a) Alternative example:		
	Uses the common ratio $12r\cos\theta = 5+2\sin\theta$, $12r^2\cos\theta = 6\tan\theta$ $\Rightarrow 12\cos\theta \left(\frac{5+2\sin\theta}{12\cos\theta} \right)^2 = 6\tan\theta$	M1	3.1a
	Multiplies up and uses $\tan\theta \times \cos\theta = \sin\theta$ $(5+2\sin\theta)^2 = 6\tan\theta \times 12\cos\theta = 72\sin\theta$	dM1	1.1b
	Proceeds to given answer $25 + 20\sin\theta + 4\sin^2\theta = 72\sin\theta$ $\Rightarrow 4\sin^2\theta - 52\sin\theta + 25 = 0$ *	A1*	2.1
		(3)	
(b)	$4\sin^2\theta - 52\sin\theta + 25 = 0 \Rightarrow \sin\theta = \frac{1}{2} \left(\frac{25}{4} \right)$	M1	1.1b
	$\theta = \frac{5\pi}{6}$	A1	1.2
		(2)	
(c)	Attempts a value for either a or r e.g. $a = 12\cos\theta = 12 \times -\frac{\sqrt{3}}{2}$ or $r = \frac{5+2\sin\theta}{12\cos\theta} = \frac{5+2 \times \frac{1}{2}}{12 \times -\frac{\sqrt{3}}{2}}$	M1	3.1a
	" a " = $-6\sqrt{3}$ and " r " = $-\frac{1}{\sqrt{3}}$ o.e.	A1	1.1b
	Uses $S_{\infty} = \frac{a}{1-r} = \frac{-6\sqrt{3}}{1+\frac{1}{\sqrt{3}}}$	dM1	2.1
	Rationalises denominator $S_{\infty} = \frac{-6\sqrt{3}}{1+\frac{1}{\sqrt{3}}} = \frac{-18}{\sqrt{3}+1} \times \frac{\sqrt{3}-1}{\sqrt{3}-1}$	ddM1	1.1b
	$(S_{\infty})9(1-\sqrt{3})$	A1	2.1
		(5)	
(10 marks)			
Notes:			

(a)

M1: For the key step in using the ratio of $\frac{a_2}{a_1} = \frac{a_3}{a_2}$
dM1: Cross multiplies and uses $\tan\theta \times \cos\theta = \sin\theta$


Alternative:

M1: Expresses the 2nd and 3rd terms in terms of the first term and the common ratio and eliminates “r”

dM1: Multiplies up and uses $\tan \theta \times \cos \theta = \sin \theta$

A1*: Proceeds to the given answer including the “= 0” with no errors and sufficient working shown.

Other approaches may be seen in (a) and can be marked in a similar way e.g. M1 for correctly obtaining an equation in θ using the GP, M1 for applying $\tan \theta \times \cos \theta = \sin \theta$ or equivalent and eliminating fractions, A1 as above

$$\text{Example: } u_2 = \frac{u_1 \times u_3}{u_2} \Rightarrow 5 + 2 \sin \theta = \frac{12 \cos \theta \times 6 \tan \theta}{5 + 2 \sin \theta} \quad \text{M1}$$

$$\Rightarrow (5 + 2 \sin \theta)^2 = 72 \sin \theta \quad \text{dM1}$$

$$25 + 20 \sin \theta + 4 \sin^2 \theta = 72 \sin \theta \quad \text{A1}$$

$$\Rightarrow 4 \sin^2 \theta - 52 \sin \theta + 25 = 0 \quad *$$

(b)

M1: Attempts to solve $4 \sin^2 \theta - 52 \sin \theta + 25 = 0$. Must be clear they have found $\sin \theta$ and not e.g. just x from $4x^2 - 52x + 25 = 0$. Working does not need to be seen but see general guidance for solving a 3TQ if necessary. Note that the $\frac{25}{2}$ does not need to be seen.

A1: $\theta = \frac{5\pi}{6}$ and no other values unless they are rejected or the $\frac{5\pi}{6}$ clearly selected here and not in (c)

A minimum requirement in (b) is e.g. $\sin \theta = \frac{1}{2}$, $\theta = \frac{5\pi}{6}$

Do **not** allow 150° for $\frac{5\pi}{6}$

PTO for the notes to part (c)



(c) Allow full marks in (c) if e.g. $\theta = \frac{\pi}{6}$ is their answer to (b) but $\theta = \frac{5\pi}{6}$ is used here.

or if e.g. $\theta = \frac{5\pi}{6}$ is their answer to (b) but $\theta = \frac{\pi}{6}$ is used here allow the M marks only.

M1: For attempting a value (exact or decimal) for either a or r using **their** θ

$$\text{E.g. } a = 12 \cos \theta = \left(12 \times -\frac{\sqrt{3}}{2}\right) \text{ or } r = \frac{5 + 2 \sin \theta}{12 \cos \theta} = \left(\frac{5 + 2 \times \frac{1}{2}}{12 \times -\frac{\sqrt{3}}{2}}\right) \text{ oe e.g. } r = \frac{6 \tan \theta}{5 + 2 \sin \theta} = \left(\frac{6 \times -\frac{1}{\sqrt{3}}}{5 + 2 \times \frac{1}{2}}\right)$$

A1: Finds both $a = -6\sqrt{3}$ and $r = -\frac{1}{\sqrt{3}}$ which can be left unsimplified but $\sin \theta = \frac{1}{2}$, $\cos \theta = -\frac{\sqrt{3}}{2}$ and $\tan \theta = -\frac{\sqrt{3}}{3}$ (if required) must have been used.

dm1: Uses both **values** of " a " and " r " with the equation $S_{\infty} = \frac{a}{1-r} = \frac{-6\sqrt{3}}{1+\frac{1}{\sqrt{3}}}$ to create an expression

involving surds where a and r have come from appropriate work and $|r| < 1$

Depends on the first method mark.

ddM1: Rationalises denominator. The denominator must be of the form $p \pm q\sqrt{3}$ oe e.g. $p + \frac{q}{\sqrt{3}}$

Depends on both previous method marks.

$$\text{Note that stating e.g. } \frac{k}{p+q\sqrt{3}} \times \frac{p-q\sqrt{3}}{p-q\sqrt{3}} \text{ or } \frac{k}{p+\frac{q}{\sqrt{3}}} \times \frac{p-\frac{q}{\sqrt{3}}}{p-\frac{q}{\sqrt{3}}} \text{ is sufficient.}$$

A1: Obtains $(S_{\infty}) 9(1-\sqrt{3})$

Note that full marks are available in (c) for the use of $\theta = 150^\circ$

Note also that marks may be implied in (c) by e.g.

$$\begin{aligned} S_{\infty} &= \frac{a}{1-r} = \frac{12 \cos \theta}{1 - \frac{5+2 \sin \theta}{12 \cos \theta}} = \frac{144 \cos^2 \theta}{12 \cos \theta - 5 - 2 \sin \theta} = \frac{144 \cos^2 \frac{5\pi}{6}}{12 \cos \frac{5\pi}{6} - 5 - 2 \sin \frac{5\pi}{6}} \\ &= \frac{108}{-6-6\sqrt{3}} = \frac{108}{-6-6\sqrt{3}} \times \frac{-6+6\sqrt{3}}{-6+6\sqrt{3}} = \frac{-648+648\sqrt{3}}{-72} = 9(1-\sqrt{3}) \end{aligned}$$

Scores M1A1 implied dm1 ddM1 A1

See next page for some other cases in (c) and how to mark them:



$$S_{\infty} = \frac{a}{1-r} = \frac{12 \cos \frac{5\pi}{6}}{1 - \frac{5 + 2 \sin \frac{5\pi}{6}}{12 \cos \frac{5\pi}{6}}} \quad \text{or e.g.} \quad S_{\infty} = \frac{a}{1-r} = \frac{12 \cos \frac{\pi}{6}}{1 - \frac{5 + 2 \sin \frac{\pi}{6}}{12 \cos \frac{\pi}{6}}}$$

And nothing else

scores M1A0dM1ddM0A0

$$S_{\infty} = \frac{a}{1-r} = \frac{12 \cos \frac{5\pi}{6}}{1 - \frac{5 + 2 \sin \frac{5\pi}{6}}{12 \cos \frac{5\pi}{6}}} = 9(1 - \sqrt{3})$$

Scores M1A1dM1ddM0A0

$$S_{\infty} = \frac{a}{1-r} = \frac{12 \cos \frac{\pi}{6}}{1 - \frac{5 + 2 \sin \frac{\pi}{6}}{12 \cos \frac{\pi}{6}}} = 9(1 + \sqrt{3})$$

Scores M1A0dM1ddM0A0

$$S_{\infty} = 9(1 - \sqrt{3}) \text{ with no working scores no marks}$$



Question	Scheme	Marks	AOs
5 (a)	Uses $115 = 28 + 5d \Rightarrow d = (17.4)$	M1	3.1b
	Uses $28 + 2 \times "17.4" = \dots$	M1	3.4
	$= 62.8 \text{ (km h}^{-1}\text{)}$	A1	1.1b
		(3)	
(b)	Uses $115 = 28r^5 \Rightarrow r = (1.3265)$	M1	3.1b
	Uses $28 \times "1.3265^4" = \dots$ or $\frac{115}{"1.3265"}$	M1	3.4
	$= 86.7 \text{ (km h}^{-1}\text{)}$	A1	1.1b
		(3)	
(6 marks)			
Notes:			

(a)

M1: Translates the problem into maths using n^{th} term $= a + (n-1)d$ and attempts to find d Look for either $115 = 28 + 5d \Rightarrow d = \dots$ or an attempt at $\frac{115-28}{5}$ condoning slipsIt is implied by use of $d = 17.4$ Note that $115 = 28 + 6d \Rightarrow d = \dots$ is M0**M1:** Uses the model to find the fastest speed the car can go in 3rd gear using $28 + 2"d"$ or equivalent. This can be awarded following an incorrect method of finding " d "**A1:** 62.8 km/h Lack of units are condoned. Allow exact alternatives such as $\frac{314}{5}$

(b)

M1: Translates the problem into maths using n^{th} term $= ar^{n-1}$ and attempts to find r It must use the 1st and 6th gear and not the 3rd gear found in part (a)Look for either $115 = 28r^5 \Rightarrow r = \dots$ o.e. or $\sqrt[5]{\frac{115}{28}}$ condoning slips.It is implied by stating or using $r = \text{awrt } 1.33$ **M1:** Uses the model to find the fastest speed the car can go in 5th gear using $28 \times "r^4"$ or $\frac{115}{"r"}$ o.e.This can be awarded following an incorrect method of finding " r "A common misread seems to be finding the fastest speed the car can go in 3rd gear as in (a).Providing it is clear what has been done, e.g. $u_3 = 28 \times "r^2"$ it can be awarded this mark.**A1:** awrt 86.7 km/h Lack of units are condoned. Expressions must be evaluated.