# PATTERNS, SEQUENCES AND SERIES

Every question, eight papers

**DBE · National Senior Certificate · Mathematics Paper 1**

November 2021 - 2024 and May/June 2021, 2022, 2024, 2025

17 questions · 205 marks · 8 papers

Each question is a clip of the original DBE page. The wording, the mark allocations and the diagrams are exactly as they were printed - nothing has been retyped or redrawn. Only the blank answer space has been removed, so work in a separate book.

## How it is arranged

One chapter per topic, so you can work through a whole skill at a time.

Inside a chapter the questions run from fewest marks to most. That is an order by size, not by difficulty: unlike the IEB, the DBE does not split its papers into an easier and a harder section, and its marking guidelines carry no cognitive-level tags. Nothing in these papers ranks one question as harder than another, so this booklet does not pretend otherwise.

## Contents

# Quadratic number patterns

Patterns whose SECOND differences are constant. The first differences are themselves an arithmetic sequence, which is the key to everything here: it gives the general term, it says where the pattern turns, and DBE likes asking questions that cross between a pattern and its own differences.

5 questions · 62 marks

9 to 17 marks each

## 1. A quadratic pattern, a difference of 33, then adding m to every term

DBE NSC Paper 1 · May/June 2025 · Q3 · 9 marks

**QUESTION 3**

Given the quadratic sequence: 14 ; 9 ; 6 ; 5 ; ...

3.1 Show that the general term of this sequence is $T_n = n^2 - 8n + 21$. (3)

3.2 Two consecutive terms of the quadratic sequence have a difference of 33. Calculate the value of the larger term. (3)

3.3 The value of $m$ is added to each term in the quadratic sequence. Determine the values of $m$ for which only the terms between $T_1$ and $T_7$ of the quadratic sequence will have negative values. (3)

**[9]**

## 2. Find b from the first difference, then the 60th term

DBE NSC Paper 1 · November 2022 · Q3 · 10 marks

**QUESTION 3**

It is given that the general term of a quadratic number pattern is $T_n = n^2 + bn + 9$ and the first term of the first differences is 7.

3.1 Show that $b = 4$. (2)

3.2 Determine the value of the $60^{th}$ term of this number pattern. (2)

3.3 Determine the general term for the sequence of first differences of the quadratic number pattern. Write your answer in the form $T_p = mp + q$. (3)

3.4 Which TWO consecutive terms in the quadratic number pattern have a first difference of 157? (3)

**[10]**

## 3. A pattern that turns, and where its terms start to fall

DBE NSC Paper 1 · November 2021 · Q3 · 11 marks

**QUESTION 3**

Consider the quadratic number pattern: $-145\ ;-122\ ;-101\ ;\ldots$

3.1 Write down the value of $T_4$. (1)

3.2 Show that the general term of this number pattern is $T_n = -n^2 + 26n - 170$. (3)

3.3 Between which TWO terms of the quadratic number pattern will there be a difference of $-121$? (4)

3.4 What value must be added to each term in the number pattern so that the value of the maximum term in the new number pattern formed will be 1? (3)

**[11]**

## 4. 3 ; 7 ; 12 ..., then what must be added to reach 13 527

DBE NSC Paper 1 · May/June 2024 · Q3 · 15 marks

**QUESTION 3**

3.1 Consider the quadratic number pattern: $3\ ;\ 7\ ;\ 12\ ;\ldots$

3.1.1 Show that the general term of this number pattern is given by $T_n = \frac{1}{2}n^2 + \frac{5}{2}n$. (3)

3.1.2 What number must be added to $T_{n-1}$ so that $T_n = 13\ 527$? (4)

3.2 Given an arithmetic sequence with $T_1 = 8$ and $T_2 = 11$.

3.2.1 Calculate the value of $n$ if $T_n = 41$. (3)

3.2.2 A new arithmetic sequence $P$ is formed using the term position and the term value of the given arithmetic sequence.
For the new sequence, $P_8 = 1$, $P_{11} = 2$ and so forth.

(a) Write down the value of $P_{41}$. (1)

(b) Calculate the value of the first term of the new arithmetic sequence. (4)

**[15]**

## 5. When a term of the pattern equals a term of its own differences

DBE NSC Paper 1 · May/June 2021 · Q2 · 17 marks

**QUESTION 2**

2.1 Consider the quadratic sequence: 72 ; 100 ; 120 ; 132 ; …

2.1.1 Determine $T_n$, the $n^{th}$ term of the quadratic sequence. (4)

2.1.2 A term in the quadratic sequence 72 ; 100 ; 120 ; 132 ; … is equal to the twelfth term of the sequence of first-differences. Determine the position of this term in the quadratic sequence. (5)

2.1.3 Determine the maximum value of the quadratic sequence. (3)

2.1.4 Determine the maximum value of the sequence:

$-23$ ; 5 ; 25 ; 37 ; … (1)

2.2 Consider the sequence: $-11$ ; $2\sin 3x$ ; 15 ; …
Determine the values of $x$ in the interval $[0°; 90°]$ for which the sequence will be arithmetic. (4)

**[17]**

# Arithmetic sequences and series

A constant difference between terms. Finding the term, finding how many terms, and summing them - and DBE often hides one of a, d and n so that you have to get it from a sum before you can do anything else.

5 questions · 74 marks

10 to 18 marks each

## 6. A linear pattern, its sum, and a sigma expansion

DBE NSC Paper 1 · November 2021 · Q4 · 10 marks

**QUESTION 4**

Consider the linear pattern: $5 ; 7 ; 9 ; \ldots$

4.1 Determine $T_{51}$. (3)

4.2 Calculate the sum of the first $51$ terms. (2)

4.3 Write down the expansion of $\sum_{n=1}^{5000}(2n+3)$. Show only the first $3$ terms and the last term of the expansion. (1)

4.4 Hence, or otherwise, calculate $\sum_{n=1}^{5000}(2n+3)+\sum_{n=1}^{4999}(-2n-1)$.
ALL working details must be shown. (4)
**[10]**

## 7. Twenty terms, then seventy-five, and the term that had to change

DBE NSC Paper 1 · November 2024 · Q2 · 14 marks

**QUESTION 2**

2.1 The first term of an arithmetic series is $7$. The common difference of this series is $5$ and the series contains $20$ terms.

2.1.1 Calculate the sum of this series. (2)

2.1.2 The original arithmetic series is extended to $75$ terms. The sum of these $75$ terms is $14\,400$. Using sigma notation, write down an equation for the sum of the terms added to the original series. (4)

2.2 The sequence of the first differences of a quadratic pattern is: $1 ; 3 ; 5 ; \ldots$

2.2.1 If $T_{99}$ of this quadratic pattern is $9\,632$, calculate the value of $T_{98}$. (3)

2.2.2 If it is further given that the third term of the quadratic pattern is $32$, determine the general term, $T_n$, of the quadratic pattern. (5)
**[14]**

## 8. From the 7th term to the number of terms, then the first forty

DBE NSC Paper 1 · May/June 2022 · Q2 · 16 marks

**QUESTION 2**

2.1 The first term of an arithmetic sequence is $-1$ and the $7^{th}$ term is $35$.

Determine:

2.1.1 The common difference of the sequence (2)

2.1.2 The number of terms in the sequence if the last term of the sequence is 473 (3)

2.1.3 The sum of the first $40$ terms in this sequence (2)

2.2 $75\ ;\ 53\ ;\ 35\ ;\ 21\ ;\ \ldots$ is a quadratic number pattern.

2.2.1 Write down the FIFTH term of the number pattern. (1)

2.2.2 Determine the $n^{th}$ term of the number pattern. (4)

2.2.3 Determine the maximum value of the following number pattern:

$$-15\ ;-\frac{53}{5}\ ;-7\ ;-\frac{21}{5}\ ;\ldots$$

(4)

**[16]**

## 9. T91 and S91, then a quadratic pattern from three differences

DBE NSC Paper 1 · November 2023 · Q2 · 16 marks

**QUESTION 2**

2.1 Given the arithmetic series: $7 + 12 + 17 + \ldots$

2.1.1 Determine the value of $T_{91}$ (3)

2.1.2 Calculate $S_{91}$ (2)

2.1.3 Calculate the value of $n$ for which $T_n = 517$ (3)

2.2 The following information is given about a quadratic number pattern:

$T_1 = 3,\ T_2 - T_1 = 9$ and $T_3 - T_2 = 21$

2.2.1 Show that $T_5 = 111$ (2)

2.2.2 Show that the general term of the quadratic pattern is $T_n = 6n^2 - 9n + 6$ (3)

2.2.3 Show that the pattern is increasing for all $n \in N$. (3)

**[16]**

## 10. An athlete's weekly kilometres as an arithmetic series

DBE NSC Paper 1 · May/June 2025 · Q2 · 18 marks

**QUESTION 2**

2.1 Given the arithmetic series: $5 + 7 + 9 + \ldots + 93$

2.1.1 Determine the general term of the series, $T_n$, in the form $T_n = pn + q$. (2)

2.1.2 The given series represents the number of kilometres that an athlete ran each week in preparation for an ultramarathon. The athlete ran 93 km in the last week of the training programme. How long, in weeks, was the training programme? (2)

2.1.3 The athlete used this opportunity to raise funds for her high school. The community sponsored her R10 for each kilometre run during the training programme. Calculate the total amount that the athlete raised for her school. (3)

2.2 The general term of a geometric sequence is $T_n = 2^{n+2}$

2.2.1 Write down:

(a) The first term (1)

(b) The common ratio (1)

2.2.2 Calculate $T_{20}$ (Write your answer as a power of 4.) (2)

2.2.3 Calculate $\sum_{n=1}^{\infty} \frac{1}{T_n}$ (3)

2.2.4 Consider the first 21 terms of the sequence $T_n = 2^{n+2}$. Calculate the sum of the terms in this sequence that are not powers of 4. (4)

**[18]**

# Geometric series, sigma and convergence

A constant ratio between terms. The sum of n terms, sigma notation read forwards and backwards, and the one case that has no equivalent in the arithmetic chapter: when the ratio is between -1 and 1 the series converges and has a sum to infinity.

7 questions · 69 marks

6 to 14 marks each

## 11. Find x, show the sum formula, then the sum to infinity

DBE NSC Paper 1 · November 2021 · Q2 · 6 marks

**QUESTION 2**

Given the geometric series: $x + 90 + 81 + \ldots$

2.1 Calculate the value of $x$. (2)

2.2 Show that the sum of the first $n$ terms is $S_n = 1\,000\left(1-(0{,}9)^n\right)$. (2)

2.3 Hence, or otherwise, calculate the sum to infinity. (2)

**[6]**

## 12. The general term, then which term of the series equals 15 625

DBE NSC Paper 1 · May/June 2021 · Q3 · 9 marks

**QUESTION 3**

3.1 If $r = \frac{1}{5}$ and $a = 2\,000$, determine:

3.1.1 $T_n$, the general term of the series (1)

3.1.2 $T_7$ (1)

3.1.3 Which term of the series will have a value of $\frac{16}{15\,625}$ (3)

3.2 Consider the geometric series where $\sum_{n=1}^{\infty} T_n = 27$ and $S_3 = 26$.

Calculate the value of the constant ratio ($r$) of the series. (4)

**[9]**

## 13. Does it converge? Then k from a sigma that comes to 29 520

DBE NSC Paper 1 · May/June 2024 · Q2 · 9 marks

**QUESTION 2**

2.1 Consider the geometric series: $4+2+1+\frac{1}{2}+\ldots$

2.1.1 Does this series converge? Justify your answer. (2)

2.1.2 Calculate $S_\infty$. (2)

2.2 Given: $\sum_{p=k}^{10} 3^{p-1} = 29\,520$. Calculate the value of $k$. (5)

**[9]**

## 14. k from a sum of 98 301, then a geometric and an arithmetic together

DBE NSC Paper 1 · November 2023 · Q3 · 10 marks

**QUESTION 3**

3.1 Given the geometric series: $3+6+12+\ldots$ to $n$ terms.

3.1.1 Write down the general term of this series. (1)

3.1.2 Calculate the value of $k$ such that: $\sum_{p=1}^{k} \frac{3}{2}(2)^p = 98\,301$ (4)

3.2 A geometric sequence and an arithmetic sequence have the same first term.

- The common ratio of the geometric sequence is $\frac{1}{3}$
- The common difference of the arithmetic sequence is $3$
- The sum of $22$ terms of the arithmetic sequence is $734$ more than the sum to infinity of the geometric sequence.

Calculate the value of the first term. (5)

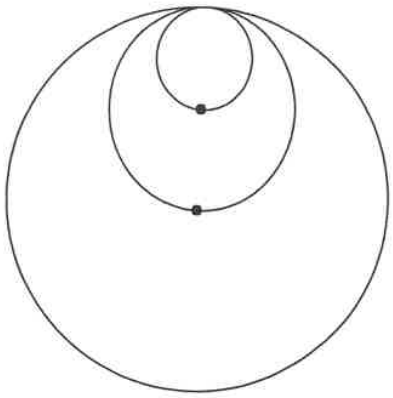
**[10]**

## 15. Circles inside circles, and the series their radii make

DBE NSC Paper 1 · November 2024 · Q3 · 10 marks

**QUESTION 3**

A circle with radius 6 cm is drawn.
A second, smaller circle is drawn through the centre of the first circle and also touches the first circle internally, as shown in the diagram.
A third, smaller circle is drawn through the centre of the second circle and touches the second circle internally. The process of drawing circles continues and forms a geometric pattern.



3.1 Write down the radius of the $3^{rd}$ circle. (2)

3.2 Calculate the sum of the areas of the first 10 circles. (4)

3.3 Which circle has a diameter of $\frac{3}{128}$ cm? (4)

**[10]**

## 16. The 10th term, then the values of t that let it converge

DBE NSC Paper 1 · May/June 2022 · Q3 · 11 marks

**QUESTION 3**

3.1 Consider the following geometric sequence: 1 024 ; 256 ; 64 ; …

Calculate:

3.1.1 The $10^{th}$ term of the sequence (2)

3.1.2 $\sum_{p=0}^{8} 256\left(4^{1-p}\right)$ (4)

3.2 The first two terms of a geometric sequence are:

$-t^2-6t-9$ and $\frac{t^3+9t^2+27t+27}{2}$

Determine the values of $t$ for which the sequence will converge. (5)

**[11]**

## 17. r from the 6th term, then how many terms reach 114 674

DBE NSC Paper 1 · November 2022 · Q2 · 14 marks

**QUESTION 2**

2.1 The first term of a geometric series is $14$ and the $6^{th}$ term is $448$.

2.1.1 Calculate the value of the constant ratio, $r$. (2)

2.1.2 Determine the number of consecutive terms that must be added to the first $6$ terms of the series in order to obtain a sum of $114\,674$. (4)

2.1.3 If the first term of another series is $448$ and the $6^{th}$ term is $14$, calculate the sum to infinity of the new series. (3)

2.2 If $\sum_{p=0}^{k}\left(\frac{1}{3}p+\frac{1}{6}\right)=20\frac{1}{6}$, determine the value of $k$. (5)

**[14]**

# Index by paper

Every patterns and sequences question in each paper, and where it sits in this booklet.

# Index by topic

A question appears under every topic it uses, so it can be found even when it is filed in another chapter.

# Where these came from

So that "every patterns and sequences question" is a claim you can check.

---

Eight DBE NSC Mathematics Paper 1 papers were read end to end:
November 2021, 2022, 2023, 2024 and May/June 2021, 2022, 2024, 2025.

All 338 questions in them were classified. These papers are scans - they carry no text layer at all - so the structure was rebuilt by reading them with OCR, and then checked three ways: every paper adds back up to exactly 150, the Afrikaans paper matches the English question for question, and the official marking guideline, which IS ordinary text, agrees with the marks read off every question.

DBE publishes an official marking guideline for every one of these papers. The companion file "CAPS_P1_Sequences_Solutions.pdf" carries the guideline for each question here, in the same order and under the same numbers.