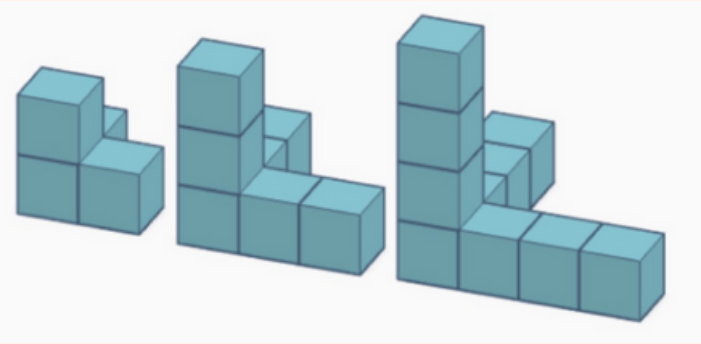
RICH MATHEMATICAL TASK BOOKLET

ALGEBRA

YEAR 7-8 ODD YEARS

Teacher Booklet

Task 1



How many different patterns can you see in this drawing?

Use diagrams to show all the patterns that you can see.

How would you draw the next position?
How would you draw the 8th position?

How many cubes would you need for the sixth position?
How many stars would you need for the 12th position?
How many stars would you need for the 24th position?

Represent what you have found in a table of data.

Teacher Notes

Have cubes available for students to construct the pattern.

Facilitate the students to notice that the pattern has a constant (the part that stays the same) and a part that grows. Support them to colour the part that stays the same in one colour and the part that grows in a different colour.

Notice students who use a table of data or a structured way of tracking the number of squares as the pattern grows. Model how to use a table of data if needed.

Expect students to move from recursive generalisation (it increases by + 3 after the first pattern) to an explicit generalisation.

For the connect, introduce letters as variables which can represent any number.

For the independent task, have multi-link cubes available to model the task.

Big Ideas

Patterns are sequences (repeating or growing) made of numeric or spatial elements governed by a rule.

Patterns exist both in the world and in mathematics. The same pattern structure can be found in many different forms (e.g., numbers, shapes, colours, and rhythm).

A pattern can be described using a rule or you can create a pattern from a rule. To find the rule for a pattern, you need to identify the unit of the pattern (what is repeated or what grows).

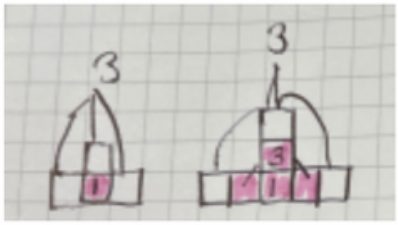
In a pattern, the relationship between the ordinal position (e.g., first, second, and third) and the corresponding element is more useful for finding the pattern's rule than the relationship between successive elements. Identifying the rule of a pattern brings predictability and allows generalisations to be developed.

Generalisations can be expressed with both words and symbols.

Variables are symbols that take the place of numbers, or ranges of numbers. They have different meanings depending on whether they are being used as representations of quantities that vary or change, representations of specific unknown variables, or placeholders in a generalised expression or formula.

Shareback

Select students to share who have represented the pattern using colours or numbers and generalised this growing in different ways. If students are using recursive reasoning, then model how this could be changed to multiplication.



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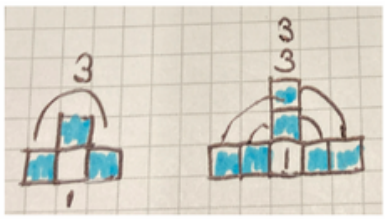


Connect

What is a rule that you could use to find the number of elements for any position? Link your rule to a representation.

Suggested Learning Outcomes

Reproduce a pattern using objects, drawings, or symbols.

Continue a linear growing pattern.

Identify the growing element and constant in a linear growing pattern.

Represent the growing element and the constant using numbers and symbols.

Represent a growing pattern in a table of data.

Develop generalisations expressed in words and symbols related to a growing pattern.

Curriculum Links

During Year 7
Identify the constant increase or decrease in a linear pattern, use variables and algebraic notation to represent the rule in an equation, and use the rule to make conjectures

During Year 8
Determine if.a pattern is linear and, if it is, write the equation for the pattern and use the equation to make conjectures.

Mathematical Language

Position, element, rule, table of data.

Independent Tasks

Parvati is making mala for a Diwali decoration. She is threading the flowers in a pattern: purple, green, red, orange, yellow, blue.

What will be the colour of the 86th flower that she threads?

Find two different ways of solving the task and representations to prove your solutions.

What do you notice about the yellow flowers in relation to their pattern position?

What rule could you use to find the location of every yellow flower?

What do you notice about the green flowers in relation to their pattern position?

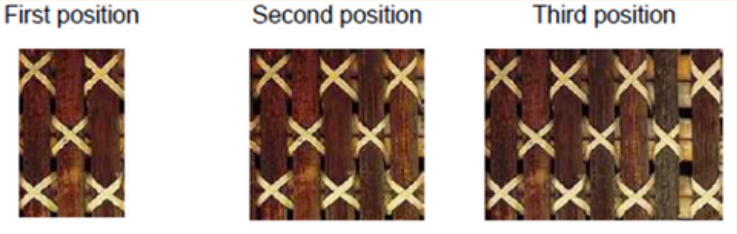
What rule could you use to find the location of every green flower?

Anticipations

Solutions, Misconceptions

Task 2

Tukutuku panels can be made from kaho (wooden rods) with tuinga (cross stitches).



How many tuinga would there be for position 6?

How many tuinga would there be for position 10?

Represent the parts of the pattern that are staying the same and the part of the pattern that changes as it grows using different colours.

How could you work out how many tuinga there would be for position 100?

Teacher Notes

During the launch, ask students to share different types of patterns that they know from their culture or every-day life.

Notice students who use recursive generalisation (add 3 each time) in relation to how the pattern grows and support them to move towards an explicit generalisation (what is the same as adding 3 multiple times?).

Expect students to represent using numbers and representations. Students could also be introduced to a table of data to show a structured way to see the relationship between the position and the total number of leaves.

For the independent task, provide students with ice-block sticks to model the pattern.

Shareback

Select students to share who have developed a generalisation to find pattern 100 including both recursive and explicit generalisations. If no students have developed an explicit generalisation, then model how to turn the recursive generalisation into an explicit generalisation.

Big Ideas

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Generalisations can be expressed with both words and symbols.

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Connect

If there were 212 tuinga, what position number would it be?

Suggested Learning Outcomes

Reproduce a pattern using objects, drawings, or symbols.

Continue a growing pattern.

Identify the growing element and constant in a linear growing pattern.

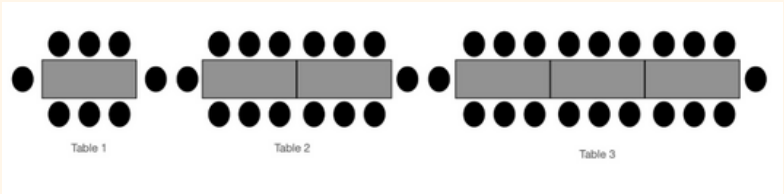
Represent the growing element and the constant using numbers and symbols.

Represent a growing pattern in a table of data.

Develop generalisations expressed in words and symbols related to a growing pattern.

Independent Tasks

Leith and Hemi are arranging seating for the Year 8 graduation dinner.



How many people can be seated at 6 tables, 15 tables, 28 tables?

Represent how the pattern grows using a table of data or graph.

How many tables do Leith and Hemi need to organise for 146 people?

Can you find the relationship between the number of tables and chairs in words or symbols and justify how the rule works with your representation.

Curriculum Links

During Year 7
Identify the constant increase or decrease in a linear pattern, use variables and algebraic notation to represent the rule in an equation, and use the rule to make conjectures

During Year 8
Determine if a pattern is linear and, if it is, write the equation for the pattern and use the equation to make conjectures.

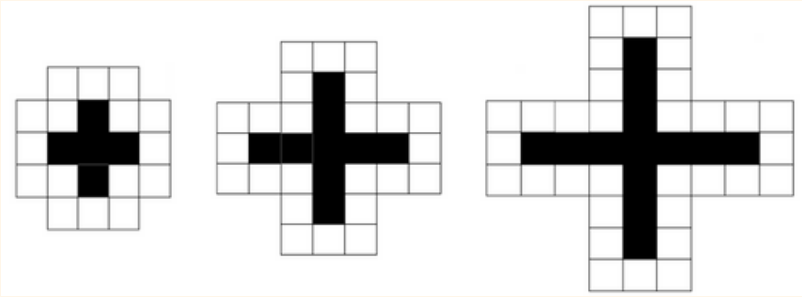
Mathematical Language

Position, element, rule, table of data.

Anticipations

Solutions, Misconceptions

Task 3



How many white tiles would there be for the fifth pattern?

How many white tiles would there be for the 10th pattern?

How do you see the pattern growing?

What is the relationship between the black tiles and the white tiles?

How many black tiles would there be for the 100th pattern?

How many white tiles would there be for the 100th pattern?

Teacher Notes

Before you launch the task, do a pattern quick image warm-up. Show the students the pattern for three seconds and ask them to describe it. Show the pattern again for three seconds and ask them to draw it. Display the pattern and ask them to draw the next term.

Have grid paper to draw the graphs for the connect.

Expect students to represent using diagrams, a table of data, numbers, and equations. If necessary for the connect, model how to create a line graph to represent how the pattern grows.

Shareback

Select students to share who recognise that the pattern increases by 8 each time and have used multiple representations (e.g., diagrams, tables of data, numbers) to show their reasoning.

Big Ideas

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Connect

Represent how the pattern grows using a line graph on the graph (squared) paper.
What rule could you use to find the number of white squares for any number of the pattern?

Suggested Learning Outcomes

Reproduce a pattern using objects, drawings, or symbols.

Continue a growing linear pattern in both directions.

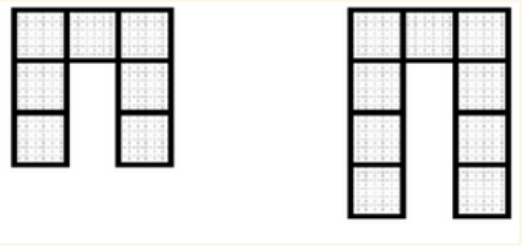
Represent a growing pattern in a table of data.

Represent a growing pattern on a graph.

Develop generalisations expressed in words and symbols related to a growing pattern.

Independent Tasks

Leoni builds a pattern with tiles. This is the second and third position:



Draw the first position of the pattern that Leoni is building.

How many tiles would the 5th position have?

How many tiles would the 9th position have?

What rule could Leoni use to work out how many tiles she would need for the 1000th position?

Curriculum Links

During Year 7
Identify the constant increase or decrease in a linear pattern, use variables and algebraic notation to represent the rule in an equation, and use the rule to make conjectures

During Year 8
Determine if.a pattern is linear and, if it is, write the equation for the pattern and use the equation to make conjectures.

Mathematical Language

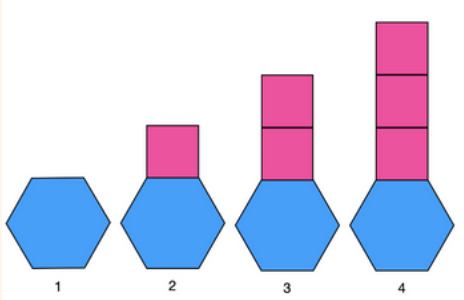
Position, element, rule, variable, graph.

Anticipations

Solutions, Misconceptions

Task 4

Chaewon was helping to design a walkway that followed this pattern:



She thought she could find a way to work out the perimeter for the walkway to buy the lining.

Complete the table:

Pattern number	Number of squares	Perimeter
1		
2		
3		
4		
5		
6		
7		
8		

What patterns can you see in the table?

What would the perimeter be if there was one hexagon and 122 squares?

Teacher Notes

Have a hexagon and square shapes to construct the pattern.

Facilitate the students to notice patterns in the table. Patterns vertically in the table may include sequential or single variational thinking (e.g., the squares increase by 1 each time) or horizontally co-variational or relational thinking (e.g., the number of squares is one less than the pattern number or the difference between the number of squares and the perimeter increases by one each time the pattern increases).

If students use recursive patterns (+ 2 for the perimeter) facilitate them to connect this to multiplication.

For the independent activity, have square tiles, ice-block sticks, and counters available and graph paper.

Big Ideas

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Shareback

Select students to share who explicitly identify the pattern in how the perimeter increases with the number of squares.

Connect

Chaewon noticed a pattern as she worked out the perimeter.
She said that the first perimeter would be six.
This is what she did to work out the second perimeter:

6 – 1 + 3
This is what she did to work out the third perimeter:
6 – 1 + 2 + 3
This is what she did to work out the fourth perimeter:
6 – 1 + 2 + 2 + 3

Does her pattern work?
How could you use this pattern to work out the perimeter for any length of the pathway?

Suggested Learning Outcomes

Reproduce a pattern using objects, drawings, or symbols.

Continue a linear growing pattern.

Identify the growing element and constant in a linear growing pattern.

Represent the linear growing element and the constant using numbers and symbols.

Represent a growing pattern in a table of data.

Identify patterns in a table of data that draw on single variational thinking and co-variational thinking.

Develop generalisations expressed in words and symbols related to a growing pattern.

Test whether a generalisation works for a growing pattern.

Curriculum Links

During Year 7
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Mathematical Language

Position, element, rule, table of data.

Independent Tasks

Develop a growing pattern to match these rules:

Squares = $5n + 2$

Ice-block sticks = $6h - 3$

Counters = $2g + 3$

Represent each pattern as a graph.

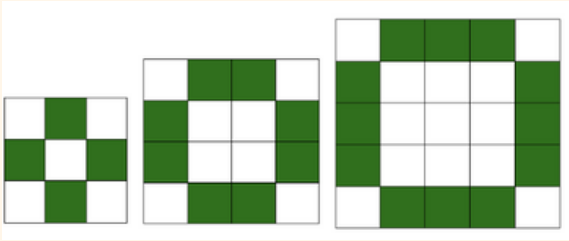
Develop your own growing patterns and write a rule to match them. Represent the pattern as a graph.

Anticipations

Solutions, Misconceptions

Task 5

Lotu was helping to design a tile pattern for a square floor. She thought she could find a way to work out how many square tiles of each colour would be needed.



What would the pattern look like for pattern 4 and 5?

Complete the table:

Pattern number	Blue squares	White squares	Total number of squares
1			
2			
3			
4			
5			
6			
7			
8			

Identify three patterns across the table and three patterns down the table.

Teacher Notes

Have square shapes or squared paper to construct the pattern.

Facilitate the students to notice patterns in the table. Patterns vertically in the table may include sequential or single variational thinking (e.g., the blue squares increase by 4 each time) or horizontally co-variational or relational thinking (e.g., the total number of squares is the blue squares plus the white squares or the number of white squares is the pattern number squared + 4.

If students use recursive patterns (+ 4 for the blue squares) facilitate them to connect this to multiplication. Facilitate the students to notice that this pattern relates to square numbers. This pattern has a range of opportunities to develop different generalisations related to the same element of the pattern. For example, for the total amount of squares, you could either add the rule for the blue squares and the rule for the white squares or use $(n+2)^2$

For the independent activity, have counters and graph or squared paper available to model the pattern.

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Shareback

Select students to share who identify co-variational patterns and relationships in the table. These can be used to develop explicit generalisations using multiplication to work out the different elements of the pattern.

Connect

How could Lotu turn the patterns that you noticed in the table into rules for different elements of the pattern?

Suggested Learning Outcomes

Reproduce a pattern using objects, drawings, or symbols.

Continue a linear growing pattern.

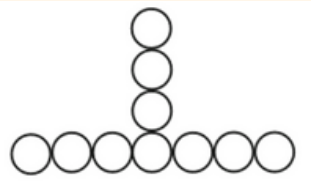
Identify the growing element and constant in a linear growing pattern.

Represent the linear growing element and the constant using numbers and symbols.

Represent a growing pattern in a table of data.

Develop generalisations expressed in words and symbols related to a growing pattern.

Independent Tasks



This is Pattern 3.

Draw what you think Pattern 2 and Pattern 1 would look like.

How many different patterns can you see in this drawing?
Show all the patterns that you can see.

Continue the pattern for Pattern 4 – 10.

Use a table of data and a graph to represent the pattern.
Explain the patterns that you have found.

Curriculum Links

During Year 7
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During Year 8
Determine if.a pattern is linear and, if it is, write the equation for the pattern and use the equation to make conjectures.

Mathematical Language

Position, element, rule, table of data.

Anticipations

Solutions, Misconceptions

Task 6

Imagine that you get a holiday job for a month. You can choose from the following options to be paid:

1. You will be paid $10 every day.
2. You will be paid $3 on the first day and this will increase by 0.50 cents each day (e.g., $3.50 on the second day; $4 on the third day).
3. You will be paid 1 cents on the first day but the amount paid will double each day (e.g., 2 cents on the second day; 4 cents on the third day).

Use a table to show how much you would earn depending on how many days are in the month.

Develop an explanation of when each option would be better than another option.

Teacher Notes

To launch the task, present the three scenarios to the students and ask them to choose which option they think will be the best without working anything out. At the end of the lesson, see whether they have changed their thinking.

Facilitate the students to notice that the different options will vary depending on the number of days in each month.

This lesson could involve students representing using number sentences and a variable and a table of data.

For the independent task, have square shapes and grid paper for the students to work with.

Shareback

Select students to share who can identify different parameters for when the options would be better and explain these using the table of data to compare the results.

Connect

If you were fired after 8 days, which option would be the best?

If you chose option 3, how many days would it be before you became a millionaire?

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Suggested Learning Outcomes

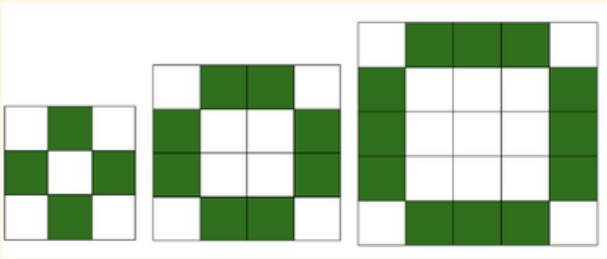
Solve number sentences with different quantities.

Represent a function in a table of data.

Compare functional situations for different quantities.

Independent Tasks

Lotu was helping to design a tile pattern for a square floor. She thought she could find a way to work out how many square tiles of each colour would be needed.



Can you find a rule to help Lotu work out how many blue square tiles she will need for any pattern number?

Can you find a rule to help Lotu work out how many white square tiles she will need for any pattern number?

Can you find a rule to help Lotu work out how many square tiles she will need in total for any pattern number?

Lotu thinks that she has found some different ways to work out the total number of square tiles. Check her ideas and see whether the rules work or not:

$(d+d+d+d+4)+d^2$

$4g + g^2 + 4$

Curriculum Links

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During Year 8
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Mathematical Language

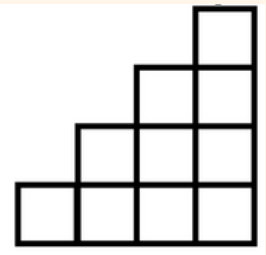
Unknown, variable, table of data.

Anticipations

Solutions, Misconceptions

Task 7

This is the fourth position for a staircase pattern:



What would the third position look like?

What would the fifth position look like?

How many squares would there be for the tenth position?

How many squares would there be for the 18th position?

Teacher Notes

This task involves a quadratic function so it is important that the students have ample opportunity to explore the patterns and discuss how they change between the numbers of staircases.

Notice whether the students are able to connect the representation to a partial rule or full rule:

$$\frac{n(n+1)}{2}$$

For the independent task, provide students with graph (squared) paper.

Shareback

Select students to share who have identified the patterns that can help them find the number of squares. For position ten, this may include combining the different numbers of squares in the lines in a structured way (e.g., 10, 9 squares and 1 square, 8 squares and 2 squares, etc).

Connect

How would you find out the number of squares for the 100th position?

What rule could you use to find the number of squares?

Big Ideas

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Suggested Learning Outcomes

Represent a pattern using drawings or a diagram.

Identify patterns related to quadratic functions.

Represent a quadratic pattern in a table of data.

Use recursive methods to predict the next member of a sequence in a non-linear pattern.

Develop generalisations expressed in words and symbols related to a quadratic pattern.

Independent Tasks

Smart data is currently offering two deals for phone data.

Deal 1 costs $12 per month for 3 GB plus $4 per GB.
Deal 2 costs $10 per month for 5 GB plus $5 per GB.

Represent each deal using a rule.

Show the results for Deal 1 and Deal 2 in a table.

Number of GB	Deal 1	Deal 2
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		

Which deal is better?

What advice would you give to someone considering both the deals?

Curriculum Links

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During Year 8
Determine if.a pattern is linear and, if it is, write the equation for the pattern and use the equation to make conjectures.

Mathematical Language

Position, element, rule, unit of repeat, variable, graph.

Anticipations

Solutions, Misconceptions

Task 8

The Fibonacci Sequence reflects growth that we can see in nature.

Each term is calculated by adding the previous two terms together.

1, 1, 2, 3, 5, 8, 13, 21

Continue the Fibonacci sequence and find the following terms.

The Fibonacci sequence also has other patterns in it.

Choose any four consecutive Fibonacci numbers. Add the first and last number and divide by two.
Record the results in a table.
What do you notice?
Can you explain it?

Adding any six consecutive Fibonacci numbers together and divide by four.
Record the results in a table.
What do you notice?
Can you explain it?

Teacher Notes

During the launch, ask students to share different types of patterns that they know from their culture or every-day life.
You might want to show the students a video to introduce Fibonacci and the golden ratio.

Support the students to continue the Fibonacci sequence and display this on the board so that the students can use it for the second part of the task.

Position the students to use different representations and diagrams including numbers and a table of data. A table of data with two columns may be introduced or modelled to support the students.

Chosen numbers	Computation	Result

For the independent task, have graph paper available.

Big Ideas

Patterns are sequences (repeating or growing) made of numeric or spatial elements governed by a rule.

Patterns exist both in the world and in mathematics. The same pattern structure can be found in many different forms (e.g., numbers, shapes, colours, and rhythm).

A pattern can be described using a rule or you can create a pattern from a rule. To find the rule for a pattern, you need to identify the unit of the pattern (what is repeated or what grows).

In a pattern, the relationship between the ordinal position (e.g., first, second, and third) and the corresponding element is more useful for finding the pattern's rule than the relationship between successive elements. Identifying the rule of a pattern brings predictability and allows generalisations to be developed.

Generalisations can be expressed with both words and symbols.

Variables are symbols that take the place of numbers, or ranges of numbers. They have different meanings depending on whether they are being used as representations of quantities that vary or change, representations of specific unknown variables, or placeholders in a generalised expression or formula.

Shareback

Select students to share who have noticed different patterns in relation to adding different consecutive Fibonacci numbers and operating on these.

Connect

What other patterns can you notice using the numbers from the Fibonacci sequence?

Suggested Learning Outcomes

Continue a growing pattern.

Identify the patterns in the Fibonacci sequence when adding consecutive numbers.

Develop generalisations expressed in words related to the patterns they have noticed in the Fibonacci sequence.

Independent Tasks

Sione and Tyrone are selling different types of chocolate bars to fundraise for the AIMs tournament.

Sione has saved $17. Additionally for each chocolate bar he sells, he gets $2.

Tyrone gets $2 per chocolate bar he sells.

Write a rule to represent each situation.

Use a table of data and graph to show when Sione and Tyrone will have the same amount of money and how many chocolate bars, Tyrone will need to sell to have more money.

Curriculum Links

During Year 7
Identify the constant increase or decrease in a linear pattern, use variables and algebraic notation to represent the rule in an equation, and use the rule to make conjectures

During Year 8
Determine if.a pattern is linear and, if it is, write the equation for the pattern and use the equation to make conjectures.

Mathematical Language

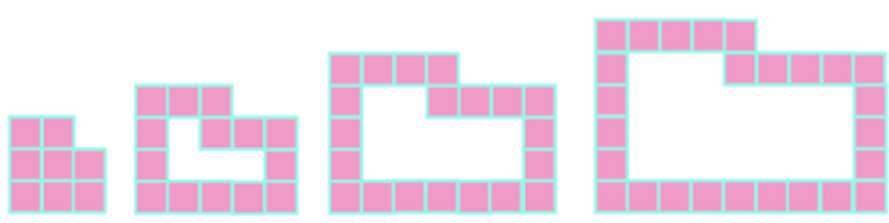
Sequence, element, rule, unit of repeat, position.

Anticipations

Solutions, Misconceptions

Task 9

Soraya is making a pattern with tiles.



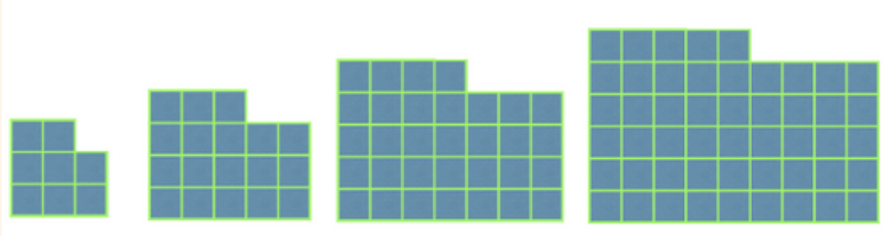
Describe the next two patterns in the sequence.

Record the number of squares in each pattern in a table of data.

How many squares would there be for the 10th pattern?

What would be a quick way to work out the number of squares in the 50th pattern?

Soraya makes a second pattern with the tiles.



What is the same and different between the two patterns?

Teacher Notes

Before you launch the task, do a pattern quick image warm-up.
Show the students the pattern for three seconds and ask them to describe it.

Show the pattern again for three seconds and ask them to draw it. Display the pattern and ask them to draw the next term.

Have square tiles to construct the pattern and grid paper to draw the graphs for the connect.

Expect students to represent using diagrams, a table of data, numbers, and equations. If necessary for the connect, model how to create a line graph to represent how the pattern grows.

Big Ideas

Patterns are sequences (repeating or growing) made of numeric or spatial elements governed by a rule.

Patterns exist both in the world and in mathematics. The same pattern structure can be found in many different forms (e.g., numbers, shapes, colours, and rhythm).

A pattern can be described using a rule or you can create a pattern from a rule. To find the rule for a pattern, you need to identify the unit of the pattern (what is repeated or what grows).

In a pattern, the relationship between the ordinal position (e.g., first, second, and third) and the corresponding element is more useful for finding the pattern's rule than the relationship between successive elements. Identifying the rule of a pattern brings predictability and allows generalisations to be developed.

Generalisations can be expressed with both words and symbols.

Variables are symbols that take the place of numbers, or ranges of numbers. They have different meanings depending on whether they are being used as representations of quantities that vary or change, representations of specific unknown variables, or placeholders in a generalised expression or formula.

Shareback

Select students to share who recognise that the pattern increases by 6 each time and have used multiple representations (e.g., physical cubes, diagrams, tables of data, numbers) to show their reasoning.

Connect

Represent how the pattern grows using a line graph on the graph (squared) paper.
Explain how your rule works using the graph.

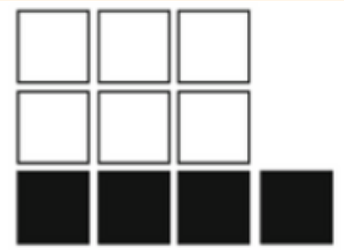
Suggested Learning Outcomes

Reproduce a pattern using objects, drawings, or symbols.

Continue a growing pattern.

Develop generalisations expressed in words and symbols related to a growing pattern

Independent Tasks



This is Pattern 3.

Draw what you think Pattern 2 and Pattern 1 would look like.

How many different patterns can you see in this drawing?
Show all the patterns that you can see.

Continue the pattern for Pattern 4 – 10.

Use a table of data to represent the pattern and explain the patterns that you have found.

Curriculum Links

During Year 7
Identify the constant increase or decrease in a linear pattern, use variables and algebraic notation to represent the rule in an equation, and use the rule to make conjectures

During Year 8
Determine if.a pattern is linear and, if it is, write the equation for the pattern and use the equation to make conjectures.

Mathematical Language

Position, element, rule, variable, graph.

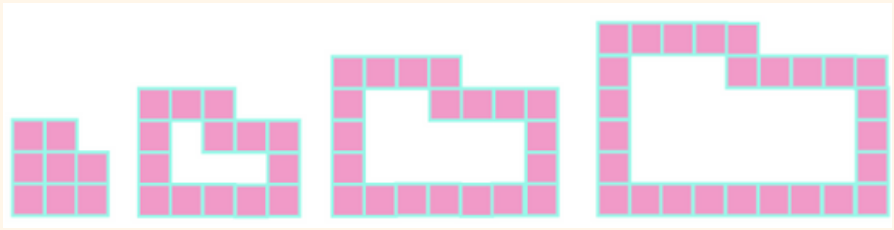
Anticipations

Solutions, Misconceptions

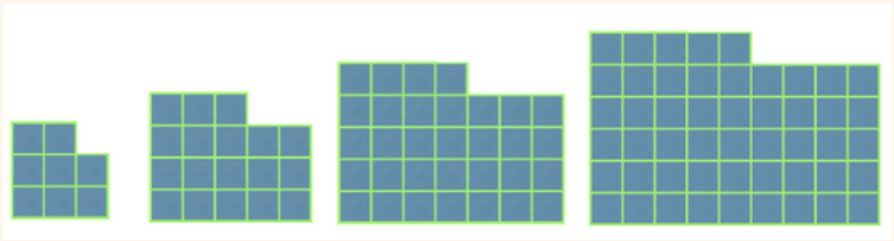
Task 10

Soraya is making a pattern with tiles.

This is her first pattern:



This is her second pattern:



For the second pattern, describe the next two patterns in the sequence.

Record the number of squares in each pattern in a table of data.

How many squares would there be for the 10th pattern?

What would be a quick way to work out the number of squares in the 50th pattern?

Think about the relationships between the two patterns. Use colours and diagrams to show the relationship between the two patterns.

Teacher Notes

To launch the task, re-visit the student solutions from the previous lesson.

Have square tiles to construct the pattern and grid paper to for students to represent the patterns and show the relationship.

Expect students to represent using diagrams, a table of data, numbers, and equations.

Big Ideas

Patterns are sequences (repeating or growing) made of numeric or spatial elements governed by a rule.

Patterns exist both in the world and in mathematics. The same pattern structure can be found in many different forms (e.g., numbers, shapes, colours, and rhythm).

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Generalisations can be expressed with both words and symbols.

Variables are symbols that take the place of numbers, or ranges of numbers. They have different meanings depending on whether they are being used as representations of quantities that vary or change, representations of specific unknown variables, or placeholders in a generalised expression or formula.

Shareback

Select students to share who are able to represent the relationship between the two patterns using colours or diagrams.

Connect

Describe the relationships between the two patterns.

Suggested Learning Outcomes

Reproduce a pattern using objects, drawings, or symbols.

Continue a growing pattern.

Develop generalisations expressed in words and symbols related to a non-linear growing pattern

Independent Tasks

Complete the following assessment tasks (attached at the end of the document) as the independent activity:

Task 1: Triangles pattern

Task 2: Necklace pattern

Curriculum Links

During Year 7
Identify the constant increase or decrease in a linear pattern, use variables and algebraic notation to represent the rule in an equation, and use the rule to make conjectures

During Year 8
Determine if.a pattern is linear and, if it is, write the equation for the pattern and use the equation to make conjectures.

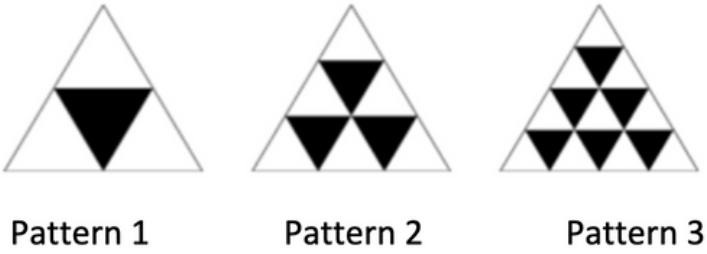
Mathematical Language

Position, element, rule, variable, graph.

Anticipations

Solutions, Misconceptions

Assessment Task 1 - Algebra - Year 7-8



Look at this growing pattern. Can you:

- Find the number of black triangles for the following pattern numbers: Pattern 6; Pattern 12; Pattern 57.
- Represent how the pattern grows using any or all of these: table, ordered pairs, graph.
- Write the rule for the number of triangles in words or symbols and justify how the rule works with your representation.
- Find the pattern number if the number of black triangles is 210.

Assessment Task 2 - Algebra - Year 7-8

First pattern Second pattern Third pattern

- Find the number of circular beads for the following pattern numbers: Pattern 6; Pattern 13; Pattern 57.
- Represent how the pattern grows using a table of data and graph.
- Write a rule for the number of circular beads in words or symbols and justify how the rule works with your representation.
- Write a rule for the total number of shapes in words or symbols and justify how the rule works with your representation.
- Find the pattern number if the number of circular beads is 248.