For Grade 5

Some things change,
some remain the same

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Alwyn Olivier and Piet Human are the principal authors of the text in this booklet.
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A publication of the Ukuqonda Institute
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1. **Number Sentences**

### 1.1 State facts

The number 80 can be formed by adding up 8 tens:

\[ 10 + 10 \rightarrow 20 + 10 \rightarrow 30 + 10 \rightarrow 40 + 10 \rightarrow 50 + 10 \rightarrow 60 + 10 \rightarrow 70 + 10 = 80 \]

The number 80 can also be formed by adding up 5 sixteens:

\[ 16 + 16 \rightarrow 32 + 16 \rightarrow 48 + 16 \rightarrow 64 + 16 = 80 \]

We can say: “Adding up 8 tens gives the same result as adding up 5 sixteens”.

A number sentence like this is called a **statement of equivalence**.

The number sentence tells us that two different actions will produce the same result. This number sentence can also be written in symbols:

\[ 10 + 10 + 10 + 10 + 10 + 10 + 10 = 16 + 16 + 16 + 16 + 16 \]

\[ 8 \times 10 = 5 \times 16 \] is a shorter sentence that gives the same information.

1. Write each number sentence in symbols.
   (a) Adding up 20 fives gives the same result as adding up 10 tens.
   (b) 25 times 8 gives the same result as 4 times 50.
   (c) The difference between 930 and 970 is the same as the difference between 430 and 470.

2. Which of these number sentences are false?
   (a) \[ 9 + 9 + 9 + 9 + 9 + 9 + 9 + 9 = 6 + 6 + 6 + 6 + 6 \]
   (b) \[ 9 + 9 + 9 + 9 + 9 + 9 = 6 + 6 + 6 + 6 + 6 + 6 \]
   (c) \[ 5 + 5 + 5 + 5 + 5 = 6 + 6 + 6 + 6 \]
   (d) \[ 9 \times 6 = 6 \times 9 \]
   (e) \[ 5 \times 6 = 6 \times 5 \]
   (f) \[ 9 \times 9 = 6 \times 6 \]

When numbers are multiplied, any of the numbers can be taken first. The answer is the same.
Richard and Thandi had to calculate $12 - 3 + 5 - 2$ and $3 \times 10 + 5 \times 2$. Richard worked like this:

- $12 - 3 = 9$
- $3 \times 10 = 30$
- $9 + 5 = 14$
- $30 + 5 = 35$
- $14 - 2 = 12$
- $35 \times 2 = 70$

Thandi worked like this:

- $3 + 5 = 8$
- $3 \times 10 = 30$
- $12 - 8 = 4$
- $5 \times 2 = 10$
- $4 - 2 = 2$
- $30 + 10 = 40$

Richard and Thandi were very confused when they compared their answers!

To avoid confusion like this, people all over the world follow certain agreements about instructions.

---

If instructions include only addition and subtraction, the calculations are done from left to right.

**Example:** $12 - 3 + 5 - 2$ means you have to do this:

- $12 - 3 = 9$
- $9 + 5 = 14$
- $14 - 2 = 12$

If instructions include multiplication, all multiplications are done before additions and subtractions.

**Examples:** $3 \times 10 + 5 \times 2$ means you have to do this:

- $3 \times 10 = 30$
- $5 \times 2 = 10$
- $30 + 10 = 40$

$3 \times 10 - 5 \times 2$ means you have to do this:

- $3 \times 10 = 30$
- $5 \times 2 = 10$
- $30 - 10 = 20$
3. Calculate.
   (a) $12 - 3 + 5 - 2$
   (b) $20 + 5 - 10 - 6 + 4$
   (c) $10 + 5 \times 5 - 3 + 7$
   (d) $10 + 5 \times 5 - 3 \times 5 + 7$

4. Which of these number sentences are false?
   (a) $100 - 50 + 30 = 100 - 80$
   (b) $3 \times 10 + 5 \times 2 = 70$
   (c) $3 \times 10 + 5 \times 2 = 40$
   (d) $3 \times 3 + 5 \times 3 = 8 \times 6$
   (e) $3 \times 3 + 5 \times 3 = 8 \times 3$
   (f) $3 \times 30 + 5 \times 30 = 8 \times 30$
   (g) $3 \times 30 + 5 \times 30 = 10 \times 30 - 2 \times 30$

Examples:
In $3 \times (4 + 6)$ the brackets are used to tell you that you must calculate like this:
   $4 + 6 = 10$ followed by $3 \times 10 = 30$

The instructions $3 \times 4 + 6$ as well as $6 + 3 \times 4$ tell you that you should calculate like this:
   $3 \times 4 = 12$ followed by $12 + 6 = 18$

$12 - (3 + 5) - 2$ means you have to do this:
   $3 + 5 = 8$ \hspace{1cm} $12 - 8 = 4$ \hspace{1cm} $4 - 2 = 2$

5. Which of these number sentences are false?
   (a) $12 - (3 + 5) - 2 = 12 - 3 + 5 - 2$
   (b) $3 \times 30 + 5 \times 30 = 3 \times (30 + 5) \times 30$
   (c) $3 \times 30 + 5 \times 30 = (3 \times 30) + (5 \times 30)$
   (d) $5 \times (20 + 3) = 5 \times 20 + 3$
   (e) $5 \times (20 + 3) = 5 \times 20 + 5 \times 3$
   (f) $5 \times (20 + 3) = 5 \times 18 + 5 \times 5$
   (g) $5 \times (20 - 3) = 5 \times 20 - 5 \times 3$
   (h) $(20 + 3) \times 5 = 20 \times 5 + 3 \times 5$
6. Which of these number sentences are false?
   (a) \((1 + 3) + (5 + 7) + 9 = 1 + (3 + 5) + (7 + 9)\)
   (b) \((10 + 8) + 6 = (8 + 6) + 10\)
   (c) \((10 + 8) + 6 = (6 + 10) + 8\)

   When more than two numbers have to be added, you can add any two of them first.

7. Which of these number sentences are false?
   (a) \(500 + 300 + 200 = 200 + 500 + 300\)
   (b) \(500 + 300 + 200 = 500 + 200 + 300\)
   (c) \(500 + 300 - 200 = 500 + 200 - 300\)
   (d) \(20 + 10 - 5 = 20 - 5 + 10\)
   (e) \((60 + 3) + (10 + 7) = (60 + 10) + (3 + 7)\)
   (f) \((60 - 7) + (10 - 3) = (60 - 10) + (7 - 3)\)
   (g) \((60 + 7) - (10 + 3) = (60 - 10) + (7 - 3)\)

8. Which of the following actions will produce the same result?
   Write your answer in the form of number sentences, for example \(3 \times 6 = 2 \times 9\).
   (a) \(6 \times 1000\)
   (b) \(60 \times 10\)
   (c) \(60 \times 100\)
   (d) \(600 \times 10\)

9. Suppose you want to know how much \(20 \times 63 + 20 \times 37\) is. Which of the following actions will produce the correct answer, and which will not?
   (a) \(20 \times 100\)
   (b) \(20 \times 60 + 20 \times 3 + 20 \times 30 + 20 \times 7\)
   (c) \(20 \times 80 \times 3 + 20 \times 50 \times 7\)
   (d) \(20 \times 60 + 20 \times 40\)
1.2 Solve and complete number sentences

1. Which number is hidden behind the red stickers?

\[ \begin{align*}
21 + \boxed{} & = 40 \\
\end{align*} \]

2. Write down the number that is hidden behind the red stickers in each number sentence.

(a) \( 30 + \boxed{} = 50 \)  
(b) \( 31 + \boxed{} = 50 \)  
(c) \( 32 + \boxed{} = 50 \)  
(d) \( 35 + \boxed{} = 50 \)  
(e) \( 30 + \boxed{} = 60 \)  
(f) \( 20 + \boxed{} = 60 \)  
(g) \( 40 + \boxed{} = 60 \)  
(h) \( \boxed{} + 40 = 60 \)  
(i) \( \boxed{} + 40 = 100 \)  
(j) \( \boxed{} + 50 = 100 \)  
(k) \( \boxed{} + 30 = 100 \)  
(l) \( \boxed{} + 20 = 100 \)  
(m) \( 25 + \boxed{} = 100 \)  
(n) \( 75 + \boxed{} = 100 \)  
(o) \( 65 + \boxed{} = 100 \)  
(p) \( 88 + \boxed{} = 100 \)

3. (a) Choose any two numbers for the blue and yellow stickers. The two numbers together must make 100.

\[ \boxed{} + \boxed{} = 100 \]

Write your answer as a number sentence, for example \( 90 + 10 = 100 \).

(b) Write a different number sentence that shows two other numbers that add up to 100.

(c) Write any other ten different number sentences that each show two numbers that add up to 100.

(d) Write ten different number sentences that each show two numbers that add up to 300.

(e) Write ten different number sentences that each show two numbers that add up to 700.
4. When you add 3 to the number behind the blue stickers, the answer is 88.

\[ \square + 3 = 88 \]

What will the answer be if you add 5 to the number behind the blue stickers?

\[ \square + 5 = ? \]

5. Simanga worked out that 46 + 74 = 120. You can see in the diagram below that his answer is right.

(a) Is it true that 120 – 74 = 46?
(b) Is it true that 120 – 46 = 74?

6. Look at the diagram below. It shows that 58 + 62 = 120. Complete these number sentences:

(a) \( 120 - 62 = \square \)  
(b) \( 120 - 58 = \square \)

7. Nontobeko knows that 78 – 35 = 43.

(a) How much is 43 + 35?
(b) How much is 78 – 43?

8. In question 5 you can read three number sentences that describe what the diagram shows.

Write three number sentences to describe what the diagram below shows.
1.3 Equivalence

Choose a number to hide behind the blue stickers in question 1. It must be the same number for each of the blue stickers. Write your blue number down.

Also choose one number to put behind the yellow stickers. It must be the same number for each of the yellow stickers. Write your yellow number down.

1. (a) How much is your \( \Box + \Box \)?
(b) Is it true that \( 10 \times (\Box + \Box) = 10 \times \Box + 10 \times \Box \)?

2. (a) Do you think the other learners in the class chose the same numbers as you to hide behind the blue and yellow stickers in question 1?
(b) Do you think the other learners in the class also found that the number sentence in question 1(b) is true, although they may have chosen different numbers than you did?

3. Choose two other numbers for your blue and yellow stickers.
   (a) Is it again true that \( 10 \times (\Box + \Box) = 10 \times \Box + 10 \times \Box \)?
   (b) Is \( 5 \times (\Box + \Box) = 5 \times \Box + 5 \times \Box \)?
   (c) Choose a number to hide behind the red stickers below.
\[ \Box \times (\Box + \Box) = \Box \times \Box + \Box \times \Box \]
   Is this number sentence true?
   (d) Is the number sentence below true?
\[ \Box \times (\Box + \Box) = \Box \times \Box + \Box \]

4. In each case state whether you think the sentence is true or false.
   (a) \( 5 \times (400 + 30 + 7) = 5 \times 400 + 30 + 7 \)
   (b) \( 5 \times (400 + 30 + 7) = 5 \times 400 + 5 \times 30 + 5 \times 7 \)
   (c) \( 5 \times (400 - 30 - 7) = 5 \times 400 - 5 \times 30 - 5 \times 7 \)
   (d) \( 5 \times (400 + 60 + 8) = 10 \times (200 + 30 + 4) \)
   (e) \( 5 \times (400 + 60 + 8) = 20 \times (100 + 15 + 2) \)
What is mathematics?

Most mathematicians and scientists say,

“Mathematics is the study of patterns.”

The more patterns you can see in mathematics, the better you are at mathematics!

So, this year, we continue studying patterns ...

You will learn that in number sequences such as the one below, there is a pattern that does not change although the numbers change: there is a horizontal and a vertical calculation plan (rule) that is the same for all the input and output numbers:

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We can describe the patterns in such sequences in words, in a table, in a flow diagram and in a calculation plan. These help us to solve problems such as the following:

1. Write down the next five numbers in the sequence 6, 12, 18, 24, ...
2. Calculate the 100th number in the sequence 6, 12, 18, 24, ...
3. Is 436 a number in the sequence 6, 12, 18, 24, ... or not?
   Explain!
2.1 Patterns in the tables

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1. Complete the above multiplication table.

2. Which method(s) did you use to complete the table? Discuss.

3. Discuss what patterns you see in the table, and how that helps you to “remember” the tables.

Sally completes the tables by using a **horizontal pattern**. The pattern is to add the same number every time, like this:

\[ 2, 4, 6, 8, 10, 12, \ldots \]

\[ 5, 10, 15, 20, 25, 30, \ldots \]

John completes the tables by using a **vertical pattern**. The pattern is to multiply by the same number every time, like this:

\[ 2 \times 2, 4 \times 2, 6 \times 2, 8 \times 2, 10 \times 2, 12 \times 2, \ldots \]

\[ 5 \times 5, 10 \times 5, 15 \times 5, 20 \times 5, 25 \times 5, 30 \times 5, \ldots \]
4. Calculate the next five numbers and the 100th number in each table below. Are you going to use Sally’s method, John’s method, or a different method altogether?

(a) 2, 4, 6, 8, 10, 12, 14, 16, ...
(b) 3, 6, 9, 12, 15, 18, 21, ...
(c) 5, 10, 15, 20, 25, 30, 35, ...
(d) 7, 14, 21, 28, 35, 42, 49, ...
(e) 9, 18, 27, 36, 45, 54, 63, ...
(f) 10, 20, 30, 40, 50, 60, 70, ...

When the tables are written like this we call each row a **sequence**. We also call them **multiples**. 3, 6, 9, ... is the sequence of **multiples of 3**.

We can also describe the sequences with a flow diagram or with a table.

5. Complete this flow diagram and table for multiples of 6. What patterns do you notice?

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2.2 Equivalent flow diagrams

1. (a) Complete Flow diagrams A and B.
   
   (b) Note that Flow diagram A has two parts of a calculation plan, and the output numbers of the first part are the input numbers for the second part. Compare Flow Diagrams A and B. How are they different, and how are they the same?

Flow diagram A

Flow diagram B

If two flow diagrams with different operators or order of operators give the same results, we say the flow diagrams are equivalent. Because they give the same results, we can choose which one we want to use.

So, because $4 = 2 \times 2$, instead of multiplying by 4, we can get the same answer by doubling, and then doubling the answer again.
(c) Madeleine says she does not have to learn the $\times 4$ tables, because she can very easily get the answer by doubling and doubling again. For example, for $4 \times 7$ she says: “7 doubled is 14 and 14 doubled is 28, so $4 \times 7 = 28$.”

Use a plan like Madeleine’s to easily calculate these:

$4 \times 8 \quad 4 \times 9 \quad 4 \times 11 \quad 4 \times 14 \quad 4 \times 23 \quad 8 \times 23 \quad 16 \times 14

2. (a) Complete Flow diagrams C, D and E.

(b) Now compare the flow diagrams. How are they different, and how are they the same?

Flow diagram C

Flow diagram D

Flow diagram E
To multiply by 6, we can multiply by 2 and then multiply the answer by 3. Or we can first multiply by 3 and then by 2. The order does not matter.

(c) Try to split the numbers into smaller factors to make these calculations easier.

\[ 9 \times 6 \quad 9 \times 12 \quad 9 \times 24 \quad 8 \times 6 \quad 11 \times 14 \quad 32 \times 12 \quad 14 \times 20 \]

3. (a) Complete Flow diagrams F, G and H.

(b) Compare the flow diagrams. How are they different, and how are they the same?

Flow diagram F

Flow diagram G
To multiply by 20, we can multiply by 2 and then multiply the answer by 10. Or we can first multiply by 10 and then multiply the answer by 2.

(c) Try to split the numbers into smaller factors to make these calculations easier.

\[9 \times 20\quad 20 \times 12\quad 20 \times 20\quad 8 \times 30\quad 8 \times 60\quad 9 \times 70\quad 9 \times 80\]

### 2.3 Sequences of non-multiples

1. For each of the sequences of multiples below, do the following:
   
   (a) Continue the sequence for the next five numbers.
   
   (b) Find the 100th number in the sequence.
   
   (c) Is 436 a number in the sequence? How do you know?

   **Sequence A:** 3, 6, 9, 12, 15, 18, ...
   
   **Sequence B:** 4, 8, 12, 16, 20, 24, ...
   
   **Sequence C:** 6, 12, 18, 24, 30, 36, ...

You already know the above sequences of multiples (tables). But what about sequences of non-multiples? Try question 2 now.
2. (a) What is the same and what is different in Sequences A to D?
   (b) Calculate the next five and the 100th number in each sequence.
   (c) For each sequence: is 436 a number in the sequence or not?

   Sequence A:  4, 8, 12, 16, 20, 24, 28, ...
   Sequence B:  5, 9, 13, 17, 21, 25, 29, ...
   Sequence C:  6, 10, 14, 18, 22, 26, 30, ...
   Sequence D:  7, 11, 15, 19, 23, 27, 31, ...

Sequences A to D have different numbers, and they all start with different numbers. But they are all the same in the sense that all of them have the same horizontal pattern:

To get the next number you add 4.
So they are family!

If they are family, how are their flow diagrams and vertical patterns the same and how are they different?

3. (a) Fill in the calculation plan (rule) for each of the sequences in question 2 in these flow diagrams.
   (b) How are the rules different, and how are they the same?

   Flow diagram A
   Flow diagram B
4. (a) Complete this table. Describe and discuss your methods.

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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position × 4 + 1</td>
<td>5</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position × 4 + 2</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position × 4 + 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) What patterns do you see in the table? What is the same in each sequence, and what is the same in each calculation plan (rule)?

5. (a) What is the same and what is different in the sequences below?

(b) Calculate the 100th number in each sequence.

(c) For each sequence: is 435 a number in the sequence or not?

   Sequence A: 5, 10, 15, 20, 25, 30, 35, ...
   Sequence B: 6, 11, 16, 21, 26, 31, 36, ...
   Sequence C: 7, 12, 17, 22, 27, 32, 37, ...
   Sequence D: 8, 13, 18, 23, 28, 33, 38, ...
   Sequence E: 9, 14, 19, 24, 29, 34, 39, ...
2.4 Flow diagrams and rules

Complete the missing parts in each of these flow diagrams.

1. \[ \begin{array}{c}
1 \\
2 \\
3 \\
4 \\
100 \\
\end{array} \quad \times 4 \quad + 3 \quad \begin{array}{c}
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\end{array} \]

2. \[ \begin{array}{c}
15 \\
19 \\
23 \\
83 \\
95 \\
\end{array} \quad \\
\begin{array}{c}
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\end{array} \quad \times 4 \quad + 3 \quad \begin{array}{c}
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\end{array} \]

3. \[ \begin{array}{c}
16 \\
20 \\
24 \\
84 \\
96 \\
\end{array} \quad \\
\begin{array}{c}
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\end{array} \quad \times 4 \quad + ? \quad \begin{array}{c}
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\end{array} \]

4. \[ \begin{array}{c}
19 \\
24 \\
29 \\
104 \\
119 \\
\end{array} \quad \\
\begin{array}{c}
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\end{array} \quad \times ? \quad + 4 \quad \begin{array}{c}
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\text{ } \\
\end{array} \]
This is a typical South African border pattern which is often put around pages, and used in pavings and on walls as decoration.

This is a Size 9 by 7 border pattern. It means that the pattern is 9 blue triangles high and 7 blue triangles wide.

1. How many blue triangles, how many black triangles, and how many triangles are there in total in the border pattern above? Describe and discuss your method.

It takes too long to count in ones!
Mary first writes down her **calculation plan** before actually calculating it:

- No. of blue triangles = $2 \times 9 + 2 \times 7 = 18 + 14 = 32$
- No. of black triangles = $2 \times 8 + 2 \times 6 = 16 + 12 = 28$
- Total no. of triangles = $32 + 28 = 60$

2. Calculate the number of blue, the number of black and the total number of triangles in these border patterns of different sizes:
   - (a) 12 by 10
   - (b) 15 by 10
   - (c) 20 by 15
3.2 From pictures to tables

Zubeida uses this growing pattern of triangles of different lengths as a border pattern to decorate different lengths of walls.

![Pattern of triangles]

1. (a) Describe Length 5 in words.
   (b) Now draw Length 5.
   (c) How many triangles are there in Length 5?

2. (a) Describe Length 50 in words.
   Do not draw it! Imagine it; “see” it in your head!
   (b) Write down a calculation plan to calculate the number of triangles in Length 50, and then calculate it.

3. Complete this table. Describe and discuss your methods. Describe and discuss patterns in the table.

<table>
<thead>
<tr>
<th>Length</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of black triangles</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of blue triangles</td>
<td>4</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total no. of triangles</td>
<td>6</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Complete this flow diagram:

![Flow diagram]
3.3 Extending patterns

1. Purple tiles and white tiles are arranged to make this growing geometric pattern:

![Images of size 1, size 2, size 3 patterns]

(a) Complete the table. Describe and discuss your method.

<table>
<thead>
<tr>
<th>Size</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of purple tiles</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of white tiles</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total no. of tiles</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) Describe and discuss horizontal and vertical numeric patterns for the purple tiles and for the white tiles and for the total number of tiles in the table.

2. Answer the same questions as in question 1 for this tile pattern.

![Images of size 1, size 2, size 3 patterns]

3. Answer the same questions as in question 1 for this tile pattern.

![Images of size 1, size 2, size 3 patterns]
3.4 Using patterns to solve problems

Anand plans to invite many friends to his birthday party. He must decide how he will seat all his friends.

He wants to make one long table by pushing a number of smaller tables together. The sketches below show different plans for seating the guests around the tables. Anand wonders which plan will be the best. Can you help him decide?

**Plan 1**

1 table 2 tables 3 tables 4 tables

**Plan 2**

1 table 2 tables 3 tables

**Plan 3**

1 table 2 tables 3 tables

**Plan 4**

1 table 2 tables 3 tables
1. For Plan 1:
   
   (a) Describe in words how the seating works. (For example: “Each small table can seat two people, plus one person at each end of the long table.”)
   
   (b) Complete this flow diagram. (You must fill in the missing input and output numbers and the calculation plan.)

   ![Flow Diagram]

   (c) Complete this table showing the relationship between the number of tables and the number of people.

<table>
<thead>
<tr>
<th>No. of tables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>15</th>
<th>46</th>
</tr>
</thead>
</table>

2. For Plan 2, answer the same questions as for Plan 1.

3. For Plan 3, answer the same questions as for Plan 1.

4. For Plan 4, answer the same questions as for Plan 1.

5. If there will be 46 people at the party (including Anand), which plan needs the fewest number of tables?
4 NUMERIC PATTERNS

4.1 More sequences

1. The cost of hiring a mega bus to travel from Johannesburg to Polokwane and back is R750.

   (a) If 30 people go on the trip, how much must each passenger pay if they share the cost equally?

   (b) If 15 people go on the trip, how much must each passenger pay if they share the cost equally?

   (c) Complete the table:

<table>
<thead>
<tr>
<th>Number of passengers</th>
<th>5</th>
<th>10</th>
<th>20</th>
<th>40</th>
<th>80</th>
<th>160</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost for each passenger (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   (d) Write a plan to show how to calculate the cost for one passenger for any number of passengers travelling on the bus.

2. For each of Sequences A to H:

   (a) Describe the patterns in your own words.

   (b) Continue the pattern for five more numbers and calculate the 20th number in the sequence.

   Sequence A: 1, 2, 4, 8, 16, 32, ...
   Sequence B: 512, 256, 128, 64, 32, ...
   Sequence C: 3, 6, 12, 24, 48, 96, ...
   Sequence D: 1, 3, 9, 27, 81, ...
   Sequence E: 2, 6, 18, 54, 162, ...
   Sequence F: 1, 4, 9, 16, 25, 36, ...
   Sequence G: 2, 5, 10, 17, 26, 37, ...
   Sequence H: 3, 6, 11, 18, 27, 38, ...
4.2 Patterns in tables

1. Avril wants to rent a car for one day. He wonders if he should rent from Image Car Rental or from AfriCars.

Both charge a **basic amount per day** plus a **rate per kilometre** for the distance driven, according to the values in the table. Avril now wonders which company is cheaper.

<table>
<thead>
<tr>
<th>Company</th>
<th>Car</th>
<th>Per day</th>
<th>Per kilometre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image</td>
<td>4-door sedan</td>
<td>R180</td>
<td>R2</td>
</tr>
<tr>
<td>AfriCars</td>
<td>4-door sedan</td>
<td>R80</td>
<td>R2,50</td>
</tr>
</tbody>
</table>

(a) Help Avril to decide which company is cheaper by completing the table of costs for AfriCars and for Image Car Rental, for travelling different distances with the hired car.

<table>
<thead>
<tr>
<th>Distance (km)</th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>250</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost: Image (R)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cost: AfriCars (R)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) What is your advice to Avril: should he hire from AfriCars or from Image Car Rental?

2. Xolile fills up his car’s tank with petrol. When full, the tank holds 60 ℓ of petrol. The table below shows how much petrol is left in the tank as Xolile drives.

<table>
<thead>
<tr>
<th>Distance driven (km)</th>
<th>0</th>
<th>40</th>
<th>80</th>
<th>120</th>
<th>160</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Petrol in tank (ℓ)</strong></td>
<td>60</td>
<td>56</td>
<td>52</td>
<td>48</td>
<td>44</td>
</tr>
</tbody>
</table>

Based on this information, how many kilometres can Xolile expect to drive until the petrol tank is completely empty?
4.3 Using patterns to solve problems

For his party, Anand arranges small square tables in a straight line, so that one person sits at each side of the table. For example, if there are 4 tables, then 10 people can sit at the tables, as shown:

1. (a) Complete this table to show how the number of people changes as the number of tables changes.

<table>
<thead>
<tr>
<th>No. of tables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>15</th>
<th>20</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of people</td>
<td>4</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) Describe your method.

(c) What patterns do you see in the table? Discuss!

2. To calculate the number of people that can sit at the tables, Anand wants to use Flow diagrams A and B below.

(a) Help Anand by completing the operators.

(b) Which flow diagram gives the correct answers, Flow diagram A or Flow diagram B?

![Flow diagram A](image)
If flow diagrams with different operators give the same output numbers for the same input numbers, they are **equivalent**. So we can choose which one to use.

3. Anand’s friend Jake is helping him to plan the party.

   Anand says, to calculate the number of people that can sit at the tables they must use this calculation plan (rule):

   \[
   \text{Number of people} = 2 \times \text{Number of tables} + 2
   \]

   Jake says they should use this plan:

   \[
   \text{Number of people} = 2 \times (\text{Number of tables} + 1)
   \]

   Who is correct, Anand or Jake?

   Complete this table using the two plans to see who is correct.

<table>
<thead>
<tr>
<th>No. of tables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>15</th>
<th>20</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2 \times \text{No. of tables} + 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2 \times (\text{No. of tables} + 1))</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In questions 2 and 3 Anand calculated the number of people as output number. It will be easier to have a flow diagram with the known number of people as input number to calculate the unknown number of tables needed.

4. Below are the two flow diagrams that you used in question 2.

(a) Change the operators so that the number of people is the input number.

(b) Then calculate the number of tables needed if Anand knows there will be 48 people at the party (including himself).
5 Geometric Patterns

5.1 Making a geometric pattern

Mathume makes this interesting sequence of pictures. He makes each new picture by repeating the same steps.

- He starts with a square (Figure 1) and colours it.
- To make Figure 2, he first draws a square of the same size as Figure 1. He then connects the midpoints of the sides of the square to form a new smaller square inside the square and then he colours the smaller square.
- To make Figure 3, he again connects the midpoints of the sides of the new square as shown.
- He continues with these same steps to make more and more pictures.

![Figure 1](image1.png) ![Figure 2](image2.png) ![Figure 3](image3.png) ![Figure 4](image4.png)

1. If we think of Figure 1 as the whole (1), what fraction of the whole figure is coloured in Figure 2? What fraction is coloured in Figure 3?

2. Complete this table to show Mathume’s geometric sequence as a numeric sequence.
   Explain your methods and discuss patterns in the table.

<table>
<thead>
<tr>
<th>Figure no.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraction of figure that is coloured</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.2 Describing patterns

Mandla makes these different patterns of bead necklaces of different sizes.

**Pattern 1**

Size 1  Size 2  Size 3  Size 4  Size 5

**Pattern 2**

Size 1  Size 2  Size 3  Size 4  Size 5

**Pattern 3**

Size 1  Size 2  Size 3  Size 4  Size 5

**Pattern 4**

Size 1  Size 2  Size 3  Size 4  Size 5
1. For Pattern 1:
   (a) Describe a Size 6 necklace in words.
       How many green beads, how many purple beads, and how many beads in total are there in a Size 6 necklace?
   (b) Describe a Size 20 necklace in words.
       How many green beads, how many purple beads, and how many beads in total are there in a Size 20 necklace?
   (c) Complete this table. Describe and discuss your methods.
       Describe and discuss what patterns you see in the table.

<table>
<thead>
<tr>
<th>Size no.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of green beads</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of purple beads</td>
<td>5</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total no. of beads</td>
<td>7</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   (d) Complete this flow diagram as a plan to calculate the total number of beads for different sizes of necklaces. Then calculate the missing output numbers.

2. For Pattern 2, answer the same questions as for Pattern 1.
3. For Pattern 3, answer the same questions as for Pattern 1.
4. For Pattern 4, answer the same questions as for Pattern 1.
5.3 Completing tables

Look at this growing geometric pattern of triangles:

![Pattern of triangles]

1. Complete this table. Describe and discuss the methods that you used.

<table>
<thead>
<tr>
<th>Figure no.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of yellow tiles</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of white tiles</td>
<td>3</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total no. of tiles</td>
<td>4</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Describe and discuss horizontal numeric patterns in the table.

3. How many triangles are there in total in Figure 50?
6 NUMBER SENTENCES

6.1 Find unknown numbers

Here is a puzzle to think about:

_Hundred minus three times a certain number is equal to four less than five times the number. What is this number?_

Can this number be 5?

Mpho investigated:

\[100 - 3 \times 5 = 100 - 15 = 85\]
\[5 \times 5 = 25 \text{ and } 4 \text{ less than } 25 \text{ is } 21.\]

No, 21 is far less than 85!

1. Investigate whether the missing number in the puzzle can be 10.
2. Investigate whether it can be 20, or maybe 15.
3. Find out what the number is!
4. Find the number that will make this number sentence true:
   \[100 - 3 \times \square = 5 \times \square - 4\]
5. (a) Investigate whether any of the numbers 20, 10 or 5 will make this number sentence true: \[4 \times \square + 7 = 6 \times \square - 9\]
   (b) For which of the three numbers you tried are \(4 \times \square + 7\) and \(6 \times \square - 9\) closest to each other?
   (c) For which of the three numbers you tried is \(4 \times \square + 7\) bigger than \(6 \times \square - 9\)?
   (d) Investigate more numbers until you find the number that makes the number sentence true.
   (e) Write ten different numbers for which \(4 \times \square + 7\) is smaller than \(6 \times \square - 9\). (We can also write \(4 \times \square + 7 < 6 \times \square - 9\).)
   (f) Write three different numbers for which \(4 \times \square + 7 > 6 \times \square - 9\).
The work that you did in questions 1, 2 and 3 can be recorded in a table:

<table>
<thead>
<tr>
<th>Number investigated</th>
<th>5</th>
<th>10</th>
<th>20</th>
<th>15</th>
<th>...</th>
<th>...</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 − 3 ( \times ) ( \square )</td>
<td>85</td>
<td>70</td>
<td>40</td>
<td>55</td>
<td>...</td>
<td>...</td>
<td>61</td>
</tr>
<tr>
<td>5 ( \times ) ( \square ) − 4</td>
<td>21</td>
<td>46</td>
<td>96</td>
<td>71</td>
<td>...</td>
<td>...</td>
<td>61</td>
</tr>
<tr>
<td>Difference</td>
<td>64</td>
<td>24</td>
<td>(56)</td>
<td>(16)</td>
<td>...</td>
<td>...</td>
<td>0</td>
</tr>
</tbody>
</table>

6. When the number was increased from 5 to 10, the difference between 100 − 3 \( \times \) \( \square \) and 5 \( \times \) \( \square \) − 4 decreased from 64 to 24.
   
   (a) What happened to the difference when the number was increased to 20?
   
   (b) What happened to the difference when the number was decreased again?

7. Try 5, 10 and other numbers until you find a number or which 40 + 3 \( \times \) \( \square \) is equal to 10 \( \times \) \( \square \) − 9.
   
   Record your work in a table like the above.

8. Try 1, 5 and 10 and other numbers until you find a number or which 5 \( \times \) \( \square \) − 12 = 4 \( \times \) \( \square \) + 12.
   
   Record your work in a table.

9. Try 2 and 100, and other numbers of your own choice until you find a number for which 3 \( \times \) \( \square \) + 50 = 5 \( \times \) \( \square \) − 70.

10. In each case, find the number that makes the number sentence true.
    
    (a) 3 \( \times \) \( \square \) + 100 = 5 \( \times \) \( \square \) − 20
    
    (b) 3 \( \times \) \( \square \) + 120 = 5 \( \times \) \( \square \)
    
    (c) 120 = 2 \( \times \) \( \square \)

11. In each case, find the number that makes the number sentence true.
    
    (a) 6 \( \times \) \( \square \) − 30 = 4 \( \times \) \( \square \) + 6
    
    (b) 200 − 3 \( \times \) \( \square \) = 5 \( \times \) \( \square \) − 56
    
    (c) 13 \( \times \) \( \square \) − 5 = 20 − 12 \( \times \) \( \square \)
6.2 Flow diagrams, number sentences and tables

1. What are the output numbers for the input numbers 5, 2 and 3 in Flow diagram A?

```
Flow diagram A
\[ \times 600 \quad + 280 \]
```

2. What are the output numbers for the input numbers 5, 2 and 3 in Flow diagram B?

```
Flow diagram B
\[ + 280 \quad \times 600 \]
```

At the private hospital Careplace you have to pay R280 to be admitted, and then R600 for each night that you sleep there.

For example, Thabile was admitted to Careplace and stayed for three nights. She had to pay \( R280 + 3 \times R600 \) which is \( R280 + R1\,800 = R2\,080 \).

3. How much do you have to pay if you are admitted to Careplace hospital and sleep there for two nights?

4. How long was Ben in the hospital if he had to pay R2 080?

5. Which of these flow diagrams show how the cost of staying at Careplace can be calculated?

```
Number of nights \[ + 280 \quad \times 600 \quad \text{Cost} \]
Number of nights \[ \times 600 \quad + 280 \quad \text{Cost} \]
```

Here is another way to describe how you can calculate the cost of staying in the private hospital Careplace:

Cost = \( 600 \times \text{the number of nights} + 280 \), or

Cost for ◻️ nights = \( 600 \times ◻️ + 280 \)
6. Calculate the total cost for admission and accommodation at the Careplace private hospital for
   (a) 6 nights  (b) 12 nights

At Goodcare private hospital the admission cost is R100 and the rate for one night is R620.

7. Calculate the total cost for admission and accommodation at the Goodcare private hospital for
   (a) 6 nights  (b) 12 nights

8. Which hospital do you think is cheaper, Careplace or Goodcare? Explain your answer.

9. Make a table like this to show the costs of staying in the Careplace or Goodcare hospitals. The costs for Thulare, a third hospital, are also shown in the table below.

<table>
<thead>
<tr>
<th>Number of nights</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Careplace</strong></td>
<td>880</td>
<td>1 480</td>
<td>2 080</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Goodcare</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Thulare</strong></td>
<td>960</td>
<td>1 460</td>
<td>1 960</td>
<td>2 460</td>
<td>2 960</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 460</td>
<td>3 960</td>
<td>4 460</td>
<td>4 960</td>
<td>5 460</td>
<td>5 960</td>
<td>6 460</td>
</tr>
</tbody>
</table>

10. When you have completed your table for question 9, look again at question 8 and at your answer. You may now give a better answer if you want to.

11. (a) What is the admission fee and the daily rate at Thulare?

       (b) Using a flow diagram or another method, describe how the cost of staying at Thulare can be calculated.