These workbooks have been developed for the children of South Africa under the leadership of the Minister of Basic Education, Mrs Angie Motshekga, and the Deputy Minister of Basic Education, Mr Enver Surty.

The Rainbow Workbooks form part of the Department of Basic Education’s range of interventions aimed at improving the performance of South African learners. As one of the priorities of the Government’s Plan of Action, this project has been made possible by the generous funding of the National Treasury. This has enabled the Department to make these workbooks, in all the official languages, available at no cost.

We hope that teachers will find these workbooks useful in their everyday teaching and in ensuring that their learners cover the curriculum. We have taken care to guide the teacher through each of the activities by the inclusion of icons that indicate what it is that the learner should do.

We sincerely hope that children will enjoy working through the book as they grow and learn, and that you, the teacher, will share their pleasure.

We wish you and your learners every success in using these workbooks.

Mrs Angie Motshekga, Minister of Basic Education

Mr Enver Surty, Deputy Minister of Basic Education
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<td>20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400</td>
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Book 1

1. Revision worksheets: R1 to R16
   Key concepts from Grade 7
2. Worksheets: 1 to 64

Book 2

3. Worksheets: 65 to 144

Name:
Doing calculations

To solve problems we need to know that we can use different words for addition, subtraction, multiplication and division. Think of some of them.

+ – ÷×

1. Calculate.
   a. 27 835 + 32 132
   b. 45 371 + 12 625 + 32 749
   c. 51 832

2. Calculate.
   a. 457 834 – 325 613
   b. 788 569 – 123 479
   c. 384 789 – 325 894

3. Calculate.
   a. 14 815 × 38
   b. 29 783 × 24
   c. 38 765 × 36

4. Calculate:
   a. 22 | 36842
   b. 63 | 96431
   c. 45 | 76593

5. Give an example of each of these properties of number.

   Commutative: Means that you can change or swap the order in which you add or multiply numbers and still get the same answer.

   Associative: Means that when adding or multiplying it doesn’t matter how you group the numbers you are adding.

What is arithmetic?

Arithmetic is the oldest and most basic part of mathematics.

It deals with the properties of numbers and the handling of numbers and quantity.

It is used by almost everyone for both simple and complex tasks, from simple everyday counting tasks to complicated business and scientific calculations.

In common usage, arithmetic refers to the basic rules for the operations of addition, subtraction, multiplication and division with smaller values of numbers.

Note that the first 16 worksheets are revision activities.
Problem solving

Either change the question into a number sentence or solve it.

What should I add to a number so that the answer will be the same as the number?

What should I multiply a number by so that the answer will be the same as the number?

If \( a \times (b + c) = (a \times b) + (a \times c) \), and \( a = -3 \), \( b = -5 \) and \( c = -2 \), substitute and solve the equation.

6. Use the commutative property to make the equation equal.

Example: \( 4 + 6 = 
\[
\begin{align*}
4 + 6 &= 6 + 4 \\
10 &= 10
\end{align*}
\]

a. \( 3 + 4 = 
\)

b. \( 8 + 4 = 
\)

7. Use the commutative property to make the equation equal.

Example: \( a + b = 
\[
\begin{align*}
a + b &= b + a
\end{align*}
\]

a. \( c + d = 
\)

b. \( f + g = 
\)

8. Use the commutative property to make the equation equal.

Example: \( 2 \times 3 = 
\[
\begin{align*}
2 \times 3 &= 3 \times 2 \\
6 &= 6
\end{align*}
\]

a. \( 4 \times 5 = 
\)

b. \( 7 \times 9 = 
\)

9. Use the commutative property to make the equation equal.

Example: \( a \times b = 
\[
\begin{align*}
a \times b &= b \times a \\
ab &= ba
\end{align*}
\]

a. \( x \times c = 
\)

b. \( m \times n = 
\)

10. Use zero as the identity of addition, or one as the identity of multiplication to simplify the following:

a. \( a \times 1 = 
\)

b. \( b \times \_ = b 
\)

c. \( e + 0 = 
\)
What did we learn before?

A Multiple is a number made by multiplying together a number and an integer, e.g. \(3 \times 4 = 12\). So 12 is a multiple of 3. The multiples of 3 are: 3, 6, 9, 12, 15, ...  

A Factor is a number which divides exactly into another number, e.g. 3 and 4 are factors of 12. All the factors (all the numbers that can divide exactly into) 12 are 1, 2, 3, 4, 6, 12.

LCM stands for lowest common multiple.  
HCF stands for highest common factor.

1. What are the first 5 multiples of:  
   Example: Multiples of 3: 3, 6, 9, 12, 15
   a. 5 ______________ b. 11 ______________ c. 8 ______________
d. 10 ______________ e. 25 ______________ f. 50 ______________

2. Write down the first 12 multiples and circle all the common multiples of each of the following pairs of numbers, and also identify the lowest common multiple (LCM).
   Example: Multiples of 4: {4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48}  
   Multiples of 5: {5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60}  
   The lowest common multiple is 20.
   a. Multiples of 2: {______________________________}
   Multiples of 3: {______________________________}
   LCM: ________________________________________
   b. Multiples of 8: {______________________________}
   Multiples of 7: {______________________________}
   LCM: ________________________________________
   c. Multiples of 9: {______________________________}
   Multiples of 10: {______________________________}
   LCM: ________________________________________
   d. Multiples of 12: {______________________________}
   Multiples of 13: {______________________________}
   LCM: ________________________________________

3. What are the factors of:  
   Example: Factors of 12: 1, 2, 3, 4, 6 and 12
   a. 15 ______________ b. 64 ______________ c. 24 ______________
d. 72 ______________ e. 80 ______________ f. 45 ______________
4. What are the common factors and the highest common factor (HCF) for these pairs of numbers?

Example:  
Factors of 12 are 1, 2, 3, 4, 6, 12  
Factors of 18 are 1, 2, 3, 6, 9, 18  
Common fractions: 1, 2, 3, 6  
HCF = 6

a. Factors of 8: {_______________________}  
Factors of 7: {_______________________}  
HCF: ________________________________  
b. Factors of 14: {_______________________}  
Factors of 12: {_______________________}  
HCF: ________________________________

c. Factors of 9: {_______________________}  
Factors of 18: {_______________________}  
HCF: ________________________________  
d. Factors of 11: {_______________________}  
Factors of 10: {_______________________}  
HCF: ________________________________

e. Factors of 15: {_______________________}  
Factors of 6: {_______________________}  
HCF: ________________________________  
f. Factors of 9: {_______________________}  
Factors of 8: {_______________________}  
HCF: ________________________________

5. Explain the following in your own words:

a. Multiples ______________________________________________________________________

b. Factors ________________________________________________________________________

6. How to use multiples and factors in mathematics is a very important skill. Here are some statements. Explain each statement and give examples of your own.

It is useful to break large numbers into smaller ones when you are asked to simplify a fraction.

Sometimes I want to check if my calculator results make sense. I then use factors and multiples to reduce the numbers to their simplest form and get an approximate answer.

Problem solving

Give all the prime numbers from 0 to 100.
Exponents

What square number and root does the diagram represent?

$3 \times 3 = 9$, so the square root of 9 is 3. We write $\sqrt{9} = 3$

a. b. c.

What is a cube root? Which diagram represents this?

$3 \times 3 \times 3 = 27$, so the cube root of 27 is 3. We write $\sqrt[3]{27} = 3$

a. b. c. d.

1. Write the following in exponential form:

Example: $13 \times 13 = 13^2$

a. $2 \times 2 = \underline{\phantom{0000}}$

b. $7 \times 7 = \underline{\phantom{0000}}$

2. Write the following as multiplication sentences:

Example: $15^2 = 15 \times 15$

a. $12^2 = \underline{\phantom{0000}}$

b. $7^2 = \underline{\phantom{0000}}$

3. Identify in $3^2$ the following: a. the base number b. the exponent

4. Write the following in exponential form:

Example: $6 \times 6 \times 6 = 6^3$

a. $3 \times 3 \times 3 = \underline{\phantom{0000}}$

b. $2 \times 2 \times 2 = \underline{\phantom{0000}}$

5. Expand the expression as shown in the example.

Example: $6^3 = 6 \times 6 \times 6$

a. $2^3 = \underline{\phantom{0000}}$

b. $4^3 = \underline{\phantom{0000}}$

6. Calculate the answers.

Example: $5^2 + 3^2 = 25 + 9 = 34$

a. $2^2 + 10^2 = \underline{\phantom{0000}}$

b. $6^2 - 3^2 = \underline{\phantom{0000}}$
7. Calculate the answers.

Example: \(5^2 + 3^3 = 25 + 27 = 52\)

<table>
<thead>
<tr>
<th>a. (6^3 - 5^2 = )</th>
<th>b. (2^2 + 3^3 = )</th>
</tr>
</thead>
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<tr>
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</table>

8. Calculate the cube root.

Example: \(\sqrt[3]{27} = \sqrt[3]{3 \times 3 \times 3} = 3\)

<table>
<thead>
<tr>
<th>a. (\sqrt[3]{8} = )</th>
<th>b. (\sqrt[3]{64} = )</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

9. Calculate.

Example: \(\sqrt[4]{16} + \sqrt[4]{25} = 4 + 5 = 9\)

<table>
<thead>
<tr>
<th>a. (\sqrt[4]{9} + \sqrt[4]{16} = )</th>
<th>b. (\sqrt[4]{100} + \sqrt[4]{81} = )</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

10. Calculate.

Example: \(\sqrt[4]{64} + \sqrt[3]{27} = 4 - 3 = 1\)

<table>
<thead>
<tr>
<th>a. (\sqrt[4]{216} + \sqrt[3]{27} = )</th>
<th>b. (\sqrt[3]{27} - \sqrt[3]{8} = )</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

11. Calculate.

Example: \(\sqrt[4]{125} + \sqrt[4]{16} = 5 + 4 = 9\)

<table>
<thead>
<tr>
<th>a. (\sqrt[4]{25} + \sqrt[4]{8} = )</th>
<th>b. (\sqrt[4]{25} - \sqrt[4]{27} = )</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

12. Calculate.

Example: \(\sqrt[4]{27} + 3^2 - \sqrt[4]{25} = 3 + 9 - 5 = 7\)

<table>
<thead>
<tr>
<th>a. (\sqrt[4]{216} + 4^2 - \sqrt[4]{16} = )</th>
<th>b. (9^2 - \sqrt[4]{27} + \sqrt[4]{4} = )</th>
</tr>
</thead>
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13. Calculate the following as fast as you can:

Example: \(10 \times 10 \times 10 \times 10 = 10000\)

<table>
<thead>
<tr>
<th>a. (10 \times 10 = )</th>
<th>b. (10 \times 10 \times 10 \times 10 = )</th>
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Exponents continued

14. Complete the table.

<table>
<thead>
<tr>
<th>Expression</th>
<th>Exponential format</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. $10 \times 10$</td>
<td>$10^2$</td>
<td>100</td>
</tr>
<tr>
<td>b. $10 \times 10 \times 10 \times 10 \times 10$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15. Calculate.

Example: $10^4 + 10^3$

- $10000 + 1000 = 11000$

a. $10^3 + 10^2 = $

b. $10^4 + 10^6 = $


Example: $4 + 10^3$

- $4 + 1000 = 1004$

a. $5 + 10^4 = $

b. $10^5 \times 9 = $

17. Calculate.

Example: $2 \times 10^4 + 3 \times 10^2$

- $20000 + 300 = 20300$

a. $3 \times 10^3 + 4 \times 10^4 = $

b. $8 \times 10^4 + 3 \times 10^2 = $

18. Calculate.

Example: $2 \times 10^4 + 3 \times 10^3 + 4 \times 10^5$

- $20000 + 3000 + 400000 = 423300$

a. $1 \times 10^2 + 8 \times 10^5 + 3 \times 10^6 = $

19. Calculate.

Example: $2^2 + 2^3 = 4 + 8 = 12$

a. $2^2 + 12^2 = $

b. $4^2 + 10^2 = $
20. Calculate.
   Example: $2^2 + 3^3 + 4^2 = 4 + 27 + 16 = 47$
   a. $2^2 + 4^3 + 3^2 =$

21. How fast can you calculate the following?
   a. $4^2 =$ ________   b. $6^2 =$ ________

22. Calculate.
   Example: $(12 - 9)^3$
   a. $(8 - 4)^3 =$
   b. $(7 + 1)^2 =$

23. Expand the expression as shown in the example. Check your answer with a calculator.
   Example: $18^4$
   a. $22^3$
   b. $81^2$

24. Expand the expression as shown in the example.
   Example: $m^4$
   a. $x^5$
   b. $7^7$

---

**Problem solving**

Add the smallest square number and the largest cube number that is smaller than 100.

Write down all the two-digit square numbers. Write down all the three-digit cube numbers.

Write one billion in exponential notation.
What is an integer?
Integers are the set of positive and negative natural numbers (including zero).
A number line can be used to represent the set of integers.

-5 -4 -3 -2 -1 0 1 2 3 4 5

Positive integers
Whole numbers greater than zero are called positive integers. These numbers are to the right of zero on the number line.

Negative integers
Whole numbers less than zero are called negative integers. These numbers are to the left of zero on the number line.

Zero
The integer zero is neutral. It is neither positive nor negative.

The sign
The sign of an integer is either positive (+) or negative (–), except for zero, which has no sign. Two integers are opposites if they are each the same distance away from zero, but on opposite sides of the number line. One will have a positive sign, the other a negative sign. In the number line below, +2 and –2 are circled as opposites.

–5 –4 –3 –2 –1 0 1 2 3 4 5

1. Complete the number lines.
   a. ___________________________
   b. ___________________________

2. Write an integer to represent each description.
   a. 8 units to the right of –3 on a number line. _______________
   b. 16 to the right of (above) zero. _______________
   c. 14 units to the right of –2 on a number line. _______________
   d. The opposite of –108. _______________
   e. 15 to the left of (below) zero. _______________

3. Put the integers in order from smallest to greatest.
   a. –41, 54, –31, –79, 57 ___________________________

4. Calculate the following: Use the number line to guide you.
   Example: –4 + 2 = –2
   a. –5 + 5 = _______
   b. 10 – 12 = _______
5. Calculate the following:

Example: $-2 + 3 - 5 = -4$

a. $-6 + 8 - 7 = \underline{3}$  
b. $9 - 11 + 2 = \underline{0}$

6. Complete the following:

a. Find $-8 + (-3)$  
b. Find $3 + (-16)$

7. Write a sum for:

a. $\underline{10}$  
b. $\underline{0}$

8. Calculate the following:

a. $4 + (-5) = \underline{-1}$  
b. $5 + (-7) = \underline{-2}$  
c. $-5 + (-7) = \underline{-12}$

9. Calculate the following:

a. $2 - (-4) = \underline{6}$  
b. $3 - (-6) = \underline{9}$  
c. $5 - (-6) = \underline{11}$

10. Calculate the following:

Example: $11 + (-23) = 11 - 23 = -12$

a. $33 + (-44) = \underline{-11}$  
b. $5 + (-43) = \underline{-38}$  
c. $-15 + (-20) = \underline{-35}$

11. Calculate the following:

Example: $-14 - (-20) = -14 + 20 = 6$

a. $-16 - 22 = \underline{-38}$  
b. $49 - (-19) = \underline{68}$  
c. $47 - (-10) = \underline{57}$

12. Solve the following:

a. $\underline{8} + 24 = -11$  
b. $\underline{23} + 10 = 33$  
c. $\underline{31} + 49 = 18$

Problem solving

Temperature is a nice way to explain positive and negative integers. Explain integers using the concept of temperature to your family.
Look at these examples and give five more examples of each.

<table>
<thead>
<tr>
<th>Proper fraction</th>
<th>Improper fraction</th>
<th>Mixed number</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{3}{4} )</td>
<td>( \frac{8}{3} )</td>
<td>( 1\frac{1}{2} )</td>
</tr>
</tbody>
</table>

**Improper fraction to mixed number**

\( \frac{8}{3} = 2\frac{2}{3} \)

**Mixed number to improper fraction**

\( 1\frac{1}{4} = \frac{5}{4} \)

1. What other fraction equals? Draw a diagram to show it.

Example: \( \frac{1}{3} = \frac{2}{6} \)

| \( \frac{1}{3} \) | \( \frac{2}{6} \) |

a. \( \frac{1}{2} = \) \[ \]

b. \( \frac{1}{7} = \) \[ \]

2. Write the next or previous equivalent fraction for:

Example: \( \frac{1}{3} = \frac{2}{6} \)

| \( \frac{1}{3} \) | \( \frac{2}{6} \) |

a. \[ \] = \( \frac{2}{5} \)

b. \[ \] = \( \frac{8}{10} \)

3. Write down three equivalent fractions for: Make a drawing.

Example: \( 1\frac{1}{3} = \frac{2}{6} = \frac{3}{9} = \frac{4}{12} \)

a. \( 1\frac{1}{2} \) \[ \]

b. \( 3\frac{2}{5} \) \[ \]

What happened to the denominators and numerators? Always start with the given number.

\[
1 + \left[ \frac{1 \times 2}{3 \times 2} \right] = 1\frac{2}{6}
\]

\[
1 + \left[ \frac{1 \times 3}{3 \times 3} \right] = 1\frac{3}{9}
\]

\[
1 + \left[ \frac{1 \times 4}{3 \times 4} \right] = 1\frac{4}{12}
\]
4. What is the highest common factor?

Example:
Highest common factor (HCF)
Factors of 4 = {1, 2, 4}
Factors of 6 = {1, 2, 3, 6}
HCF = 2
So 2 is the biggest number that can divide into 4 and 6.

a. Factors of 3: 
Factors of 4:

b. Factors of 5: 
Factors of 10:

5. Write in the simplest form.

Example:
\[
\frac{12}{16} = \frac{\cancel{12}}{\cancel{4}} = \frac{3}{4}
\]
HCF:
Factors of 12: {1, 2, 3, 4, 6, 12}
Factors of 16: {1, 2, 4, 8, 16}

a. \(\frac{6}{18}\) 

b. \(\frac{5}{25}\)

6. Add the two fractions, write the total as a mixed number and simplify if necessary.

Example:
\[
\frac{1}{3} + \frac{4}{3} = \frac{5}{3} = 1\frac{2}{3}
\]
When we add fractions the denominators should be the same.

a. \(\frac{2}{5} + \frac{4}{5}\) 

b. \(\frac{5}{9} + \frac{6}{9}\)

7. Calculate and simplify if necessary.

Example:
\[
\frac{1}{2} \times \frac{2}{4} + \frac{1}{4} = \frac{2}{4} + \frac{1}{4} = \frac{3}{4}
\]
Remember, when we add fractions the denominators should be the same.

To find the LCM (Lowest common multiple)
Multiples of 2 = {2, 4, 6, 8, ...}
Multiples of 4 = {4, 8, 12, 16, ...}
... or in this case the denominators are multiples of each other.
2 is a multiple of 4. See on the left how we do this.

a. \(\frac{1}{4} + \frac{1}{2}\) 

b. \(\frac{1}{5} + \frac{1}{10}\)
8. Add the two fractions. Then multiply the two fractions.

Example: \( \frac{1}{2} + \frac{1}{3} \)

Addition: \( \frac{1}{2} + \frac{1}{3} \)

Multiplication: \( \frac{1}{2} \times \frac{1}{3} \)

LCM = 6

\( \frac{3}{6} + \frac{2}{6} = \frac{5}{6} \)

\( \frac{1}{6} = \frac{5}{6} \)

I see that when I multiply fractions the answer gets smaller, but when I multiply positive integers the number gets bigger.

That is true. If you take two six packs of juice, you get 12 juices. But if you take half (\( \frac{1}{2} \)) of a six pack (\( \frac{1}{3} \)) you get 3 juices.

a. \( \frac{1}{2} \times \frac{1}{12} = \)

b. \( \frac{1}{2} \times \frac{1}{11} = \)

9. Calculate.

Example: \( \frac{1}{2} \times \frac{1}{3} \times \frac{1}{4} \)

\( \frac{1}{24} \)

a. \( \frac{1}{3} \times \frac{1}{5} \times \frac{1}{2} = \)

b. \( \frac{1}{2} \times \frac{1}{5} \times \frac{1}{9} = \)

10. Calculate and simplify.

Example 1: \( \frac{6}{7} \times \frac{5}{7} \)

\( \frac{30}{49} \)

Example 2: \( \frac{6}{7} \times \frac{5}{6} \)

\( \frac{30}{42} + \frac{6}{8} \)

a. \( \frac{7}{8} \times \frac{2}{4} = \)

11. Write down different sums that will give you these answers. Give them all. State what fractions you are multiplying by each other.

Example: \( \frac{3}{3} \times \frac{4}{5} = \frac{12}{15} \)

A whole number \times a proper fraction.

A proper fraction \times improper fraction.

a. \( \frac{3}{3} \times \frac{4}{5} = \frac{12}{15} \)

b. \( \frac{2}{8} \times \frac{6}{3} = \frac{12}{18} \)

a. \( \_ \times \_ = \frac{2}{4} \)

b. \( \_ \times \_ = \frac{8}{4} \)
12. Calculate and simplify

Example: \[ 8 \times \frac{1}{4} = \]
\[ = \frac{8}{1} \times \frac{1}{4} \]
\[ = \frac{8}{4} \]
\[ = 2 \]

a. \[ 2 \times \frac{3}{5} = \]

b. \[ 4 \times \frac{5}{5} = \]

13. What whole number and fraction will give you the following answer?

Example: \[ \frac{2}{3} \times \frac{1}{3} = \]
\[ = 2 \times \frac{1}{3} \]

a. \[ \frac{7}{21} \times \frac{1}{3} = \]

14. Simplify the following:

Example: \[ \frac{15}{20} \]
\[ = \frac{15}{20} + \frac{5}{5} \]
\[ = \frac{3}{4} \]

a. \[ \frac{4}{12} \]

b. \[ \frac{8}{16} \]

15. Multiply and simplify the answer if possible.

Example: \[ \frac{1}{3} \times \frac{3}{4} = \]
\[ = \frac{3}{12} \div \frac{3}{3} \]
\[ = \frac{1}{4} \]

a. \[ \frac{1}{2} \times \frac{4}{8} = \]

b. \[ \frac{1}{2} \times \frac{2}{7} = \]

Problem solving

Name five fractions that are between one fifth and four fifths.

What is \( \frac{1}{8} + \frac{3}{8} \) in its simplest form?

What is \( \frac{3}{9} \times \frac{3}{4} \) in its simplest form?

If the answer is \( \frac{42}{72} \), what are two fractions that have been multiplied?

If \( \text{____ (whole number)} \times \text{____ (fraction)} = \frac{24}{36} \), how many possible solutions are there for this sum?

Can two unit (unitary) fractions added together or multiplied together give you a unit fraction as an answer?

Multiply any two improper fractions and simplify your answer if necessary.
Revision

Percentages and decimal fractions

Look at the following. What does it mean?

\[
\frac{47}{100} = 0.47 = 47\%
\]

Where in everyday life do we use:

- Decimal fractions?
- Percentages?

1. Write each of the following percentages as a fraction and as a decimal fraction.
   
   Example: 18% or \(\frac{18}{100}\) or 0.18
   
   a. 37%  
   b. 83%

2. Calculate.
   
   Example: 40% of R40
   
   \[
   \frac{40}{100} \times \frac{40}{1} = \frac{1600}{100} = R16
   \]
   
   a. 20% of R24  
   b. 70% of R15

3. Calculate.
   
   Example:
   
   \[
   \frac{60}{100} \times \frac{300}{1} = \frac{3}{5} \times \frac{300}{1} = \frac{900}{5} = R180
   \]
   
   a. 80% of R1,60  
   b. 24% of R72

I can write 60% as \(\frac{60}{100}\).

60\% simplified is \(\frac{6}{10} = \frac{3}{5}\).

You may use a calculator.
4. Calculate the percentage increase.

Example:

Calculate the percentage increase if the price of a bus ticket of R60 is increased to R84.

\[ \frac{24}{60} \times \frac{100}{1} = \frac{240}{60} = 40 \]

Therefore an increase of 40%.

a. R80 to R96

Price increase: _______

5. Calculate the percentage decrease.

Example:

Calculate the percentage decrease if the price of petrol goes down from 20 cents a litre to 18 cents. Amount decreased is 2 cents.

\[ \frac{2}{20} \times \frac{100}{1} = \frac{200}{20} = 10 \]

Therefore a decrease of 10%.

a. R50 of R46

Price decrease: _______

6. Write the following in expanded notation:

Example: 6,745 = 6 + 0.7 + 0.04 + 0.005

a. 3,983 _______

b. 8,478 _______

7. Write the following in words:

Example: 5,854 = 5 units + 8 tenths + 5 hundredths + 4 thousandths

a. 9,764 ___________________________

b. 7,372 ___________________________

8. Write down the value of the underlined digit.

Example: 9,624 = 0.09 or 9 hundredths

a. 8,378 _______

b. 4,32 _______

9. Write there as decimal fractions:

Example: \( \frac{40}{100} = 0.4 \)

a. \( \frac{6}{10} \) _______

b. \( \frac{7}{10} \) _______
10. Write as decimal fractions.

Example: \( \frac{73}{100} \)

a. \( \frac{45}{100} \)  

b. \( \frac{76}{100} \)

11. Write as decimal fractions.

Example: \( \frac{85}{10} \)

a. \( \frac{36}{10} \)  

b. \( \frac{6705}{100} \)

12. Write as common fractions.

Example: \( \frac{43}{10} \)

a. 9,5  

b. 15,15

13. Write the following as decimal fractions.

Example: \( \frac{2}{5} = 0,4 \)

a. \( \frac{1}{5} \)  

b. \( \frac{1}{4} \)

14. Round off to the nearest unit.

Example: 6,7

\( \approx 7 \)

a. 5,1  

b. 14,8

15. Round off to the nearest tenth.

Example: 3,745

\( \approx 3,7 \)

a. 6,14  

b. 3,578

16. Calculate using both methods shown in the example.

Method 1: \( 2,37 + 4,53 \)

\( = (2 + 4) + (0,3 + 0,5) + (0,07 + 0,03) \)

\( = 6 + 0,8 + 0,1 \)

\( = 6,9 \)

Method 2: \( 2,37 + 4,53 \)

\( = 6,90 \)

a. 6,89 + 3,67 =  

b. 4,694 + 3,578 =
17. Calculate. Check your answers using a calculator.

Example 1:
- \(0.2 \times 0.3 = 0.06\)
- \(0.02 \times 0.3 = 0.006\)
- \(0.002 \times 0.3 = 0.0006\)

Do you notice the pattern? Describe it.

\[
a. \ 0.4 \times 0.2 = \\
b. \ 0.3 \times 0.1 =
\]

18. Calculate. Check your answers using a calculator.

Example 1: \(0.3 \times 0.2 \times 100\)  
Example 2: \(0.3 \times 0.2 \times 10\)

\[
a. \ 0.4 \times 0.2 \times 10 = \\
b. \ 0.5 \times 0.02 \times 10 =
\]

19. Calculate. Check your answers using a calculator.

Example 1: \(5.276 \times 30\)

\[
a. \ 1.123 \times 10 = \\
b. \ 4.886 \times 30 =
\]

20. Calculate the following:

Example: \(0.4 \div 2\)

\[
a. \ 0.8 \div 4 = \\
b. \ 0.6 \div 3 = 
\]

21. Calculate the following:

Example: \(0.25 \div 5\)

\[
a. \ 0.81 \div 9 = \\
b. \ 0.85 \div 5 = 
\]

Multiplying the number that will be exactly between 2.25 and 2.26 by the number that is equal to ten times three.

You need nine equal pieces from 54.9 m of rope. How long will each piece be?

My mother bought 32.4 m of rope. She has to divide it into four pieces. How long will each piece be?
Revise R7 Input and output

Draw in the missing arrows in the flow diagram and fill in the output values.

Use the flow diagram on the left.
What will the output be, if the rule is:

- \(\times 5\)
- \(\times 7\)
- \(\times 8\)
- \(\times 4\)
- \(\times 12\)

The rule is \(\times 9\).

1. Use the given rule to calculate the value of \(b\).

Example:

\[
\begin{array}{c|c}
 a & b \\
3 & 3 \\
2 & 2 \\
5 & 5 \\
7 & 7 \\
4 & 4 \\
\end{array}
\]

If \(c = 5\), then \(b = a \times 5\)
so:
\[
\begin{align*}
3 \times 5 &= 15 \\
2 \times 5 &= 10 \\
5 \times 5 &= 25 \\
7 \times 5 &= 35 \\
4 \times 5 &= 20 \\
\end{align*}
\]

The rule is ________.

2. Complete the flow diagrams. Show all your calculations.

Example:

\[
\begin{array}{c|c|c}
 a & b & a \times 2 + 4 \\
4 & 12 & 4 \\
6 & 16 & 6 \\
7 & 18 & 7 \\
8 & 20 & 8 \\
9 & 22 & 9 \\
\end{array}
\]

\[
\begin{array}{c|c}
 a & b \\
4 & 12 \\
6 & 16 \\
7 & 18 \\
8 & 20 \\
9 & 22 \\
\end{array}
\]

\[
\begin{align*}
 a &\text{ is the input,} \\
b &\text{ is the output,} \\
b &= a \times 2 + 4 \text{ is the rule.} \\
\end{align*}
\]

\[
\begin{align*}
b &= 4 \times 2 + 4 = 12 \\
b &= 6 \times 2 + 4 = 16 \\
b &= 7 \times 2 + 4 = 18 \\
b &= 8 \times 2 + 4 = 20 \\
b &= 9 \times 2 + 4 = 22 \\
\end{align*}
\]

The rule is ________.

\[
\begin{array}{c|c|c}
 b & a & h \\
2 & 23 & 10 \\
6 & 10 & 9 \\
1 & 9 & 7 \\
10 & 7 & 8 \\
11 & 8 & \\
\end{array}
\]

\[
\begin{array}{c|c|c}
 h & g & g \\
23 & 23 & \\
10 & 10 & \\
9 & 9 & \\
7 & 7 & \\
8 & 8 & \\
\end{array}
\]

\[
\begin{align*}
g &= h \times 1 - 16 \\
g &= 23 \times 1 - 16 \\
g &= 17 \\
\end{align*}
\]

The rule is ________.
3. Complete the tables.

**Example:** \( x = y + 2 \)

<table>
<thead>
<tr>
<th>( y )</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x )</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>22</td>
</tr>
</tbody>
</table>

| \( x = 2 + 2 \) | \( x = 4 + 2 \) |
| \( y \) | 4 | 6 | 8 | 10 | 12 | 22 |
| \( x \) | 4 | 6 | 8 | 10 | 12 | 22 |

\( a = b + 9 \)

| \( b \) | 1 | 2 | 3 | 4 | 5 | 10 |
| \( a \) |   |   |   |   |   |   |

\( a = 2 + 2 \)

| \( x \) | 4 | 6 | 8 | 10 | 12 |
| \( x \) | 4 | 6 | 8 | 10 | 12 |

4. Solve for \( m \) and \( n \).

**Example:**

| \( x \) | 1 | 2 | 3 | 4 | 14 | 25 |
| \( y \) | 6 | 7 | 8 | 9 | 19 | 22 |

\( m? \)

**Determine the rule:**

E.g. \( y = x + 5 \)

\( n? \)

| \( x \) | 1 | 2 | 3 | 4 | 14 | 25 |
| \( y \) | 10 | 11 | 12 | 13 | n | 39 |

\( n? \)

\( m? \)

| \( x \) | 1 | 2 | 3 | 4 | 14 | 25 |
| \( y \) | 6 | 7 | 8 | 9 | 19 | 22 |

**Rule:**

\( x = m \) and \( y = 22 \)

\( y = x + 5 \)

\( 22 = m + 5 \)

\( 17 = m \)

\( m = 17 \)

**Problem solving**

- **Draw a flow diagram where** \( x = y + 9 \).
- **Draw your own flow diagram where** \( x = y \times 4 + 8 \).
- **What is the 10th term in this pattern?** 2 x 11, 3 x 11, 4 x 11, ...
- **If** \( x = 2y + 4 \) **and** \( y = 2, 3, 4, 5, 6, \) **draw a table to show it.**
Revise the following:

Say if the following is an expression or an equation and why?

\[ x + 23 = 45 \]

1. Say whether it is an expression or an equation.

Example: 8 + 3 (It is an expression.)
8 + 3 = 11 (It is an equation.)

a. 9 + 7 = 16
b. 7 + 6
c. 3 + 5 = 8
d. 11 + 2

2. Describe the following:

Example: 6 + 3 = 9
6 + 3 is an expression that is equal to the value on the right-hand side, 9.
6 + 3 = 9 is called an equation. The left-hand side of an equation equals the right-hand side.

a. 12 + 5 = 17
b. 9 + 8 = 17
3. Describe the following in words:

Example: 4, 8, 12, 16, 20, ...
Adding 4 to the previous term.

a. 2, 5, 8, 11 ...

b. 11, 20, 29, 38 ...

4. Write down an expression for the \( n \)th term of each sequence.

Example: 5, 9, 13, 17, 21 ...
Expression or rule: \( 4(n) + 1 \)

<table>
<thead>
<tr>
<th>Position in sequence</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>( n )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term</td>
<td>5</td>
<td>9</td>
<td>13</td>
<td>17</td>
<td>21</td>
<td>( 4(n) + 1 )</td>
</tr>
</tbody>
</table>

a. 6, 11, 16, 21 ...

b. 7, 13, 19, 25 ...

5. What does the rule mean?

Example: The rule \( 2n - 1 \) means for the following number sequence: 1, 3, 5, 7, 9 ...

<table>
<thead>
<tr>
<th>Position in sequence</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>( n )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

The rule \( 6n - 2 \) means for the following number sequence 4, 10, 16, 22 ...

<table>
<thead>
<tr>
<th>Position in sequence</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Term</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

continued
6. Solve for $x$.

Example 1:

- $x + 5 = 9$
- $x + 5 - 5 = 9 - 5$
- $x = 4$

a. $x + 18 = 26$

b. $x + 6 = 12$

c. $x - 15 = 12$

d. $x - 28 = 13$

e. $x + 7 = -12$

f. $x + 24 = -34$

Example 2:

- $x - 5 = 2$
- $x - 5 + 5 = 2 + 5$
- $x = 7$

c. $x - 15 = 12$

d. $x - 28 = 13$

e. $x + 7 = -12$

Example 3:

- $x + 4 = -7$
- $x + 4 - 4 = -7 - 4$
- $x = -11$

f. $x + 24 = -34$
7. Solve for $x$.

Example: $5x = 20$

\[
\frac{5x}{5} = \frac{20}{5} \\
\therefore x = 4
\]

a. $6x = 72$  

b. $7x = 84$

8. Solve for $x$.

Example: $2x - 1 = 8$

\[
2x - 1 + 1 = 8 + 1 \\
2x = 9 \\
\frac{2x}{2} = \frac{9}{2} \\
\therefore x = 4 \frac{1}{2}
\]

a. $5x - 6 = 18$  

b. $3x + 4 = -5$


Example: if $y = x^2 + 2$,

\[
\text{calculate } y \text{ when } x = 4 \\
y = 4^2 + 2 \\
y = 16 + 2 \\
y = 18
\]

Test

\[
y = x^2 + 1 \\
18 = 4^2 + 2 \\
18 = 16 + 2 \\
18 = 18
\]

a. $y = p^2 + 7; p = 8$  

b. $y = c^2 + 4; c = 8$

---

Problem solving

Write down five different equations where $x$ is equal to 5.
A line graph uses points connected by lines to show how something changes in value (as time goes by, or as something else happens).

1. Look at the graph and answer the following questions.

a. What is the title of the graph? ____________________________________________

b. What does the x-axis tell us? ____________________________________________

c. What does the y-axis tell us? ____________________________________________

d. What does this graph tell us? ____________________________________________

e. What can you add to the word “temperature” on the y-axis? __________________

f. What was the temperature on:
   i.   Sunday? ________
   ii.  Monday? ________
   iii. Wednesday? ________

g. Identify the grid lines on the graph that helped you to answer the previous question. ________________________________________________________________

h. Look at the temperature on Sunday and Monday. What do you notice? _________________________________________________________________

i. What happened to the temperature from Wednesday to Thursday? _____________
2. Look at the graph and label it.

- title
- x-axis
- y-axis
- points
- grid lines

3. Fill in the missing words (lines, title, label, vertical scale, points or dots, horizontal scale).

a. The ________ of the graph tells us what the graph is about.

b. The horizontal ________ across the bottom and the vertical ________ along the side tell us what kinds of facts are listed.

c. The ________________ across the bottom and the ________________ along the side tell us how much or how many, or what.

d. The ________ on the graph show us the facts.

e. The ________ connecting the points give estimates of the values between the points.

---

**Problem solving**

Find a graph in a newspaper. Write down five points about the graph.
Can you remember the meaning of the following?

- **Profit** is the surplus left over after total costs are deducted from total revenue.
- **Loss** is the excess of expenditure over income.
- **Discount** is the amount deducted from the asking price before payment.
- **Budget** is the estimate of cost and revenues over a specified period.
- **Interest** is the fee a lender charges a borrower for the use of borrowed money, usually expressed as an annual percentage of the amount borrowed, also called the interest rate.

A **loan** is sum of money that an individual or a company lends to an individual or company with the objective of gaining profits when the money is paid back.

1. Are you making a profit or a loss? How much? Circle the correct answer and calculate the amount.
   
   a. You are buying ice creams for R4,50 each and selling them for R6,00 each. You made a profit/loss of ____________ (amount) per ice cream.

   b. You bought 150 pencils for R1,00 each and sold them for R1,35 each. You had to give your mother R60 for transport costs. You made a profit/loss of ____________ (amount).

2. Answer the questions on profit.
   
   a. You are buying sweets for 80c each and you want to sell them and make a 25% profit. How much must you sell them for? ____________ (amount).

   b. You are buying sweets in large packets of 100 for R25,50 per packet. You are selling them to your friends for 50c per sweet. If they buy 10 sweets or more at a time you give them 20% discount. During the first break you sold 40 loose sweets and 20 sweets at the discounted price. What will your profit be on the sweets you sold? _______ (amount).

**Profit** can be calculated by different methods. Normally when we talk about a 10% profit we calculate it on the cost price. We sometimes also refer to a 10% mark-up.

**Example:** If my tennis racquet costs me R400 and I want to sell it and make a 10% profit, I need to sell it for R440.

\[ R400 + (R400 \times 10\%) = R440 \]

**Spend less than you earn!**

Creating a budget is the most important step in controlling your money. The first rule of budgeting is: **Spend less than you earn!**

**Example:** If you get R100 allowance per month (pocket money) and another R40 for your birthday, you cannot spend more than R140 for the entire month.

**Net income** is what remains after all the costs are deducted from total revenue. If the costs or expenses exceed the income we call it a **shortage.**
3. **Track your budget.**

Using the example below, draw up a budget in your writing book. Make sure you make a net income.

<table>
<thead>
<tr>
<th>Income</th>
<th>Estimated amount</th>
<th>Actual amount</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated total income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expenses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated total expenses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net income</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When someone lends money to someone else, the borrower usually pays a fee to the lender. This fee is called ‘interest’, ‘**simple**’ interest, or ‘**flat rate**’ interest. The amount of simple interest paid each year is a fixed percentage of the amount borrowed or lent at the start.

The simple interest formula is as follows:

\[
\text{Interest} = \text{Principal} \times \text{Rate} \times \text{Time}
\]

where:

- **Interest** is the total amount of interest paid,
- **Principal** is the amount lent or borrowed,
- **Rate** is the percentage of the principal charged as interest each year.
- **Time** is the time in years that it will take to pay back the loan.

4. I borrowed R10 000 from the bank and they charged me 10% interest per year. The total amount I had to repay was R15 000. For how long was the loan?

**Sharing**

Make notes of the important financial tips you have learned, and share them with a family member.
Symbols you need to revise or learn:

<table>
<thead>
<tr>
<th>Triangle</th>
<th>Angle</th>
<th>Perpendicular</th>
<th>Parallel</th>
<th>Degrees</th>
<th>Right angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Δ]</td>
<td>[∠]</td>
<td>[⊥]</td>
<td>[∥]</td>
<td>[°]</td>
<td>[∟]</td>
</tr>
</tbody>
</table>

Line segments | Line | Ray | Congruent | Similar | Therefore |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AB</td>
<td>AB</td>
<td>AB</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Geometric figures to remember:

- **Triangles**
  - Equilateral triangle
  - Isosceles triangle
  - Scalene triangle

- **Quadrilaterals**
  - Parallelogram
  - Rectangle
  - Square
  - Rhombus
  - Trapezium
  - Kite

- **More polygons**
  - Pentagon
  - Hexagon
  - Heptagon
  - Octagon
  - Nonagon
  - Decagon, etc.

- **These are also polygons**

**Angles to remember:**

- **Acute angle:** an angle that is less than 90°
- **Right angle:** an angle that is 90°
- **Obtuse angle:** an angle that is greater than 90° but less than 180°
- **Straight angle:** an angle that is exactly 180°
- **Reflex angle:** an angle that is greater than 180°

**Term 1**

1. **Measure each angle.** (You might need to extend the lines depending on the size of your protractor.)
   
   a. 
   
   [Diagram of angle a]
   
   b. 
   
   [Diagram of angle b]
   
   c. 
   
   [Diagram of angle c]
   
   d. 
   
   [Diagram of angle d]
2. Draw an angle:

a. Smaller than 90 degrees. Estimate the size of your angle, then measure it.

b. Bigger than 90 degrees. Estimate the size of your angle, then measure it.

3. Use a ruler and protractor to draw a 60° angle labelled ABC. Write down the steps you take to construct it.

continued
4. Using a compass, go through the steps for constructing a line labelled CD perpendicular to both sides of a line labelled AB.

5. Label the circle.
   a. Use the following words: chord, diameter, radius and centre.
   b. Draw a circle with a diameter of 2.3 cm.

6. Construct an equilateral, isosceles and a scalene triangle. Label each triangle.
7. Construct a parallelogram, rectangle, square, rhombus, trapezium and kite. Label each diagram.

a.  

b.  

c.  

d.  

e.  

f.  

8. How do I know when triangles are congruent or similar?

a. Congruent:

b. Similar:

---

**Problem solving**

The most common angle we get in everyday life is a 90º angle. Name at least five everyday examples of angles smaller than 90º. Make drawings to show your answers.
Transformations

Look at the transformations and describe each one.

Transformation: to transform something is to change it in some way.

A transformation is what brings about the change. There are many kinds of geometric transformations, ranging from translations, rotations, reflections to enlargements.

Translation: a translation is the movement of an object to a new position without changing its shape, size or orientation.

When a shape is transformed by sliding it to a new position, without turning, it is said to have been translated.

Rotation: a rotation is a transformation that moves points so that they stay the same distance from a fixed point, the centre of rotation.

Rotational symmetry
A figure has rotational symmetry if an outline of the turning figure matches its original shape.

Order of symmetry
This is how many times an outline matches the original in one full rotation.

Reflection: a reflection is a transformation that has the same effect as a mirror.

Reflective symmetry
An object is symmetrical when one half is a mirror image of the other half.

1. Describe each reflection. The words below may help you.

<table>
<thead>
<tr>
<th>Mirror</th>
<th>Shape</th>
<th>Original</th>
<th>Line of</th>
<th>Vertical</th>
<th>Horizontal</th>
</tr>
</thead>
<tbody>
<tr>
<td>image</td>
<td></td>
<td>shape</td>
<td>reflection</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. 

b. 

c.
2. Describe each rotation. The words below may help you.

<table>
<thead>
<tr>
<th>Rotate</th>
<th>Clockwise</th>
<th>Anti-clockwise</th>
<th>Centre of rotation</th>
<th>Degrees</th>
<th>Horizontal</th>
</tr>
</thead>
</table>

a.  

b.  

c.  

3. Describe each translation. The words below may help you.

<table>
<thead>
<tr>
<th>Slide</th>
<th>Left</th>
<th>Right</th>
<th>Up</th>
<th>Down</th>
<th>Place</th>
</tr>
</thead>
</table>

a.  

b.  

c.  

4. Fill in the answers:

Orange rectangle:
a. The length =  
b. The width =  

Blue rectangle:
c. The length =  
d. The width =  
e. The blue rectangle is the orange rectangle enlarged times.

Problem solving

Find a translated, rotated and reflected pattern in nature and explain each one in words.
1. Label the following using these words: face, edge and vertex.
   a. 
   b. 

2. Write a comparison of geometric figures and geometric solids.

3. Describe the net of this geometric solid.
   a. Name the geometric solid. 
   b. Identify and count the faces. 
   c. Identify and count the vertices and edges. 
3. Complete the table.

<table>
<thead>
<tr>
<th>Solid</th>
<th>Vertices</th>
<th>Edges</th>
<th>Faces</th>
<th>Formula V – E + F</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Triangular prism</td>
<td>6</td>
<td>9</td>
<td>5</td>
<td>6 – 9 + 5 = 2</td>
</tr>
<tr>
<td>b. Rectangular prism</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Pentagonal prism</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Hexagonal prism</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Octagonal prism</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Triangular pyramid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Square pyramid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Pentagonal pyramid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Hexagonal pyramid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. Octagonal pyramid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Problem solving
Which geometric objects do you see most in your everyday life?
Revision

14
Perimeter and area

Revise.

- Perimeter of a **rectangle**: \(2l \times 2b\)
- Area of a rectangle: \(l \times b\)
- Perimeter of a **square**: \(4l\)
- Area of a square: \(l \times l\)
- The area of a **triangle** is: \(\frac{1}{2}bh\)

1 cm = 10 mm
1 cm\(^2\) (1 cm \(\times\) 1 cm) = 100 mm\(^2\) (10 mm \(\times\) 10 mm)

1 m = 1 000 mm
1 m\(^2\) (1 m \(\times\) 1 m) = 1 000 000 mm\(^2\) (1 000 mm \(\times\) 1 000 mm)

1 km = 1 000 m
1 km\(^2\) (1 km \(\times\) 1 km) = 1 000 000 m\(^2\) (1 000 m \(\times\) 1 000 m)

1. Calculate the perimeter and the area of the following polygons:

**Example: Rectangle**

**Perimeter:**
Double 4.5 cm + double 3.2 cm
\((2 \times 4.5 \text{ cm}) + (2 \times 3.2 \text{ cm})\)
= 9 cm + 6.4 cm
= 15.4 cm

**Area:**
4.5 cm \(\times\) 3.2 cm
= 14 cm\(^2\)

**Term 1**

<table>
<thead>
<tr>
<th>Perimeter:</th>
<th>Area:</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 2.9 cm</td>
<td></td>
</tr>
<tr>
<td>1.4 cm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>b. 1.5 cm</td>
<td></td>
</tr>
<tr>
<td>1.4 cm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td></td>
</tr>
<tr>
<td>3 cm</td>
<td></td>
</tr>
<tr>
<td>5 cm</td>
<td></td>
</tr>
</tbody>
</table>

**Area:**

**Perimeter:**
2. Draw the triangle and then calculate the area.

Height 3 cm
Base 5 cm

<table>
<thead>
<tr>
<th>Drawing</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Measure the triangle and calculate the area in mm² and cm².

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

4. Work out the area and give your answer in m², cm² and mm².

**Example:** length = 2 m, breadth = 1 m

\[
\text{Area} = l \times b = 2 \text{ m} \times 1 \text{ m} = 2 \text{ m}^2
\]

\[
\text{Area} = l \times b = 200 \text{ cm} \times 100 \text{ cm} = 20000 \text{ cm}^2
\]

\[
\text{Area} = l \times b = 2000 \text{ mm} \times 1000 \text{ mm} = 2000000 \text{ mm}^2
\]

5. If the area of a square is 64 000 000 mm², what are the length and breadth in cm and m?

**Example:**

\[
\text{Area} = 9000000 \text{ mm}^2
\]

\[
= 3000 \text{ mm} \times 3000 \text{ mm}
\]

\[
= 300 \text{ cm} \times 300 \text{ cm}
\]

\[
= 90000 \text{ cm}^2
\]

\[
= 3 \text{ m} \times 3 \text{ m}
\]

\[
= 9 \text{ m}^2
\]

**Calculation:**

Problem solving

If a square has a perimeter of 10 m, what is the area? Give your answer in mm² and cm². If you change the square to a rectangle with a perimeter 10 m, will the area change?
What is the difference between volume and capacity?

1. Use a formula to calculate the volumes of the cubes. How much water can each cube hold?

Example:
The formula for the volume of a cube is $\ell^3$.

\[
\begin{align*}
\text{a.} & \quad 5 \text{ cm} \\
\text{b.} & \quad 4.5 \text{ cm}
\end{align*}
\]

2. Calculate the volume of this container and give your answer in m$^3$, cm$^3$ and mm$^3$. Also say what the capacity of this container is when filled with water.

Example:
This container will hold 30 000 000 ml or 30 000 ℓ water

\[
\begin{align*}
\text{m}^3 & \quad l \times b \times h \\
5 \text{ m} \times 2 \text{ m} \times 3 \text{ m} & \quad = 30 \text{ m}^3 \\
\text{cm}^3 & \quad l \times b \times h \\
500 \text{ cm} \times 200 \text{ cm} \times 300 \text{ cm} & \quad = 30 000 000 \text{ cm}^3 \\
\text{mm}^3 & \quad l \times b \times h \\
5000 \text{ mm} \times 2000 \text{ mm} \times 3000 \text{ mm} & \quad = 30 000 000 000 \text{ mm}^3
\end{align*}
\]
3. Calculate the surface area of the following cubes.

Example:

The surface area of a cube is \( l \times l \times \text{total number of faces} \)

\[
= (4 \text{ cm})^2 \times \text{total faces} \\
= 16 \text{ cm}^2 \times 6 \\
= 96 \text{ cm}^2
\]
4. Calculate the surface area of the following rectangular prisms:

- a. 3 cm
- b. 4.2 cm

4 cm 3.5 cm
2.5 cm

4 cm 3.5 cm
3.5 cm
2.5 cm
Problem solving

If the volume of a cube is 112 cm³, what is its dimension in mm and m³?
1. Answer the questions about collecting data.

How much water do we drink at school?

a. How will you find the data?

b. Who should you ask?

c. What will the data tell you?

d. Do you think the data can help you to solve the problem?

e. Why will the data help you to solve any possible problem?
2. You collected data by interviewing children in your class about their favourite sport. The results are as follows:

<table>
<thead>
<tr>
<th>Name</th>
<th>Favourite colour</th>
<th>Name</th>
<th>Favourite colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denise</td>
<td>Rugby</td>
<td>Elias</td>
<td>Soccer</td>
</tr>
<tr>
<td>John</td>
<td>Golf</td>
<td>Simon</td>
<td>Rugby</td>
</tr>
<tr>
<td>Jason</td>
<td>Soccer</td>
<td>Edward</td>
<td>Cricket</td>
</tr>
<tr>
<td>Mathapelo</td>
<td>Cricket</td>
<td>Susan</td>
<td>Soccer</td>
</tr>
<tr>
<td>Beatrix</td>
<td>Cricket</td>
<td>Philip</td>
<td>Golf</td>
</tr>
<tr>
<td>Opelo</td>
<td>Rugby</td>
<td>Ben</td>
<td>Rugby</td>
</tr>
<tr>
<td>Lisa</td>
<td>Soccer</td>
<td>Lauren</td>
<td>Tennis</td>
</tr>
<tr>
<td>Gugu</td>
<td>Golf</td>
<td>Tefo</td>
<td>Rugby</td>
</tr>
<tr>
<td>Sipho</td>
<td>Rugby</td>
<td>Alicia</td>
<td>Soccer</td>
</tr>
<tr>
<td>Lerato</td>
<td>Rugby</td>
<td>Masa</td>
<td>Tennis</td>
</tr>
</tbody>
</table>

a. Compile a table showing tally and frequency.
b. Draw a bar graph using your frequency table.

c. Interpret your graph and write at least 5 conclusions.

3. Use the data collected from a survey of the favourite subjects in your class. You will need extra paper to do this activity.

<table>
<thead>
<tr>
<th>Name</th>
<th>Favourite subject</th>
<th>Name</th>
<th>Favourite subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denise</td>
<td>Maths</td>
<td>Elias</td>
<td>History</td>
</tr>
<tr>
<td>John</td>
<td>Arts</td>
<td>Simon</td>
<td>Maths</td>
</tr>
<tr>
<td>Jason</td>
<td>History</td>
<td>Edward</td>
<td>Sciences</td>
</tr>
<tr>
<td>Mathapelo</td>
<td>Sciences</td>
<td>Susan</td>
<td>History</td>
</tr>
<tr>
<td>Beatrix</td>
<td>Sciences</td>
<td>Philip</td>
<td>Arts</td>
</tr>
<tr>
<td>Opelo</td>
<td>Maths</td>
<td>Ben</td>
<td>Maths</td>
</tr>
<tr>
<td>Lisa</td>
<td>History</td>
<td>Lauren</td>
<td>Language</td>
</tr>
<tr>
<td>Gugu</td>
<td>Arts</td>
<td>Tefo</td>
<td>Maths</td>
</tr>
<tr>
<td>Sipho</td>
<td>Maths</td>
<td>Alicia</td>
<td>History</td>
</tr>
<tr>
<td>Lorato</td>
<td>Maths</td>
<td>Masa</td>
<td>Language</td>
</tr>
</tbody>
</table>

a. Compile a frequency table using tallies, splitting the results for boys and girls.

b. Draw a double bar graph using your frequency table, comparing the preferences of the boys and girls.

c. Interpret your graph and write at least 5 conclusions.

d. Compare the graph in 2b with the double bar graph in 3b. Which graph gives the more detailed information.
4. Write a short report on your findings.

5. Why is this a histogram? Write two sentences on this histogram that explain the data.

6. Currently every person in South Africa generates about 2 kg of solid waste per day. Draw a pie chart to display this information.

This table shows the different categories of solid waste and the amount in grams generated per day.

<table>
<thead>
<tr>
<th>Waste category</th>
<th>Waste generated per person per day (in grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic</td>
<td>240</td>
</tr>
<tr>
<td>Glass</td>
<td>120</td>
</tr>
<tr>
<td>Paper</td>
<td>600</td>
</tr>
<tr>
<td>Metal</td>
<td>200</td>
</tr>
<tr>
<td>Organic</td>
<td>600</td>
</tr>
<tr>
<td>Non-recyclables</td>
<td>240</td>
</tr>
</tbody>
</table>
Rainbow Workbooks

Grade 8 Mathematics

PART 2 WORKSHEETS 1 to 64

ENGLISH Book 1
Natural numbers, whole numbers and integers

Explain the difference between:

**Natural numbers:**
\{1, 2, 3, 4, \ldots\} No negative numbers and no fractions.

**Whole numbers:**
\{0, 1, 2, 3, \ldots\} No negative numbers and no fractions. Zero included.

**Integers:**
\{\ldots -3, -2, -1, 0, 1, 2, 3, \ldots\} Positive and negative numbers. Includes zero (which is neither positive nor negative). No fractions.

The symbol for each: \(N\) \(W\) \(Z\)

1. **Read the cartoon and discuss it.**

2. **Draw number lines explaining the following:**
   - Natural numbers
   - Whole numbers
   - Integers

Write a set for each group of numbers.

- Natural numbers
- Whole numbers
- Integers
- Natural numbers
- Whole numbers
- Integers
3. Say whether the following numbers are natural numbers and/or whole numbers and/or integers.

<table>
<thead>
<tr>
<th>Number</th>
<th>Natural Numbers</th>
<th>Whole Numbers</th>
<th>Integers</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. -8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. -6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. 100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. 200</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Complete the following:

a. A = {1, 2, 3, ...} is the set of ____________ numbers.
b. B = {0, 1, 2, ...} is the set of ____________ numbers.
c. C = {... -3, -2, -1, 0, 1, 2, 3, ...} is the set of ____________ numbers.
d. Sometimes we talk about positive and negative integers. Write a set for each.

5. Label this Venn diagram using the words: integers, naturals and whole numbers.

A Venn Diagram is a way of showing the relationship between two or three sets of numbers. The diagram is made up of two or three overlapping oval shapes.

6. Do you know of any other types of numbers? Write them down.

Problem solving

Explain what a Venn diagram is to your family.
Revise these properties of numbers. Give an example of each.

**Commutative property of numbers:**

**Associative property of numbers:**

**Distributive property of numbers:**

**Zero as the identity property of addition:**

**One as the identity property of multiplication:**

1. Make use of the associative property to show that the expressions are equal:

   **Example:**  \((6 + 3) + 4 = 6 + (3 + 4)\)
   
   9 + 4 = 6 + 7
   
   13 = 13

   a. \((2 + 5) + 3 =\)
   
   b. \((4 + 6) + 2 =\)
   
   c. \((7 + 8) + 1 =\)

2. Use the associative property to show the expressions are equal.

   **Example:**  \((a + b) + c = a + (b + c)\)
   
   \(a + b + c = a + b + c\)

   a. \((m + n) + p =\)
   
   b. \((x + y) + z =\)
   
   c. \((c + d) + e =\)
3. Use the commutative property to show the expressions are equal.

**Example:**
\[2 \times 3 = 3 \times 2\]
\[6 = 6\]

a. \(5 \times 10 =\)  
   \[\square\]  

b. \(4 \times 5 =\)  
   \[\square\]  

c. \(7 \times 9 =\)  
   \[\square\]

4. Use the commutative property to show the expressions are equal.

**Example:**
\[a \times b = b \times a\]
\[ab = ba\]

a. \(x \times c =\)  
   \[\square\]  

b. \(m \times n =\)  
   \[\square\]  

c. \(p \times q =\)  
   \[\square\]

5. Make use of the associative property to show the expressions are equal.

**Example:**
\[8 + (7 + 4) = (8 + 7) + 4\]
\[= 15 + 4\]
\[= 19\]

a. \(3 + (6 + 7) =\)  
   \[\square\]  

b. \(12 + (4 + 9) =\)  
   \[\square\]  

c. \(5 + (3 + 11) =\)  
   \[\square\]  

continued
6. Use the associative property to show the equation is true.

Example: \[ a + (b + c) = (a + b) + c \]
\[ a + b + c = a + b + c \]

a. \[ x + (y + z) = \]

b. \[ r + (s + t) = \]

c. \[ d + (e + f) = \]

7. Use the associative property to show the equation is true.

Example: \[ (2 \times 4) \times 3 = 2 \times (4 \times 3) \]
\[ 8 \times 3 = 2 \times 12 \]
\[ 24 = 24 \]

a. \[ (3 \times 4) \times 3 = 3 \times (4 \times 3) \]

b. \[ (7 \times 4) \times 2 = 7 \times (4 \times 2) \]

8. Use the associative property to show the equation is true.

Example: \[ a \times b \times c = (a \times b)c \]
\[ abc = ab \times c \]
\[ abc = abc \]

a. \[ (c \times d \times e) = c(d \times e) \]

b. \[ x \times y \times z = x(y \times z) \]
9. Show that the following equations are true, by using the distributive property.
   a. \(3 \times (2 + 6) = (3 \times 2) + (3 \times 6)\)
   
   
   b. \(5 \times (3 + 3) = (5 \times 3) + (5 \times 3)\)
   
   
   c. \(3 \times (7 + 4) = (3 \times 7) + (3 \times 4)\)
   

10. Prove that the following expressions are true, by using the distributive property.
   a. \(m \times (n + p) = (m \times n) + (m \times p)\)
   
   
   b. \(d \times (g + h) = (d \times g) + (d \times h)\)
   
   
   c. \(r \times (s + t) = (r \times s) + (r \times t)\)
   

11. Use zero as the identity of addition and one as the identity of multiplication to write sums for the following:

<table>
<thead>
<tr>
<th></th>
<th>Zero as the identity of addition</th>
<th>One as the identity of multiplication</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\frac{1}{2})</td>
<td>(\frac{1}{2} + 0 = \frac{1}{2})</td>
<td>(\frac{1}{2} \times 1 = \frac{1}{2})</td>
</tr>
<tr>
<td>a. 3,5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. 56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. (\frac{1}{3})</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Problem solving

If \(a \times (b + c) = (a \times b) + (a \times c)\) and \(a = -5, b = -2\) and \(c = -3\), in the equation to show that the distributive property holds.
- What should I add to a number so that the answer will be the same as the number?
- What should I multiply a number by so that the answer will be the same as the number?
Factors, prime factors and factorising

Definitions

1. What is a factor? Give an example.

2. Write the factors for:

   Example: Factors of 16 = {1, 2, 4, 8, 16}

   a. Factors of 8 = […]
   b. Factors of 24 = {…}
   c. Factors of 21 = {…}

3. What is a prime number? Give five examples.

4. Revision. Complete the table.

<table>
<thead>
<tr>
<th></th>
<th>Factors</th>
<th>Common factors</th>
<th>Highest common factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: 4 and 8</td>
<td>1, 2, 4 and 1, 2, 4, 8</td>
<td>1, 2, 4</td>
<td>4</td>
</tr>
<tr>
<td>a. 6 and 12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. 7 and 28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. 9 and 36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. 8 and 24</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. 3 and 21</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. What does HCF stand for?
6. What is the HCF for:

Example: Factors of 12: \{1, 2, 3, 4, 6, 12\}  
Factors of 16: \{1, 2, 4, 8, 16\}

a. 15 and 45  
b. 16 and 64  
c. 21 and 63  
d. 24 and 88

7. Use the ladder or tree methods of factorisation to find the highest common factors.

Example: Factors of 24 and 36

<table>
<thead>
<tr>
<th>24</th>
<th>2</th>
<th>36</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>2</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HCF: \(2 \times 2 \times 3 = 12\)

Check your answer: 24 ÷ 12 = 2 
36 ÷ 12 = 3

a. Factors of 24 and 32  
b. Factors of 64 and 32  
c. Factors of 48 and 36  
d. Factors of 72 and 32

Problem solving

Factorise 358.  
What is the sum of the highest common factor of 100 and 150 together with the highest common factor of 200 and 250?
Multiples and the lowest common multiple

Look at the definitions. Give five examples of each.

**Multiple:**
A number made by multiplying two other numbers together. They can be positive or negative whole numbers or zero.

**LCM (Lowest common multiple):**
The smallest number that is a multiple of two or more numbers.

1. Write the first 12 multiples for:
   
   **Example:** Multiples of 9: \{9, 18, 27, 36, 45, 54, 63, 72, 81, 90, 99, 108\}
   
   a. Multiples of 2: \{…\}
   
   b. Multiples of 4: \{…\}
   
   c. Multiples of 7: \{…\}
   
   d. Multiples of 3: \{…\}

2. What does LCM stand for?

3. Determine the lowest common multiple.

   **Example:**
   
   Multiples of 4: \{4, 8, 12, 16, 20\}  LCM is 20  Multiples of 5: \{5, 10, 15, 20\}
   
   a. Multiples of 8: \{…\}  Multiples of 5: \{…\}
   
   b. Multiples of 5: \{…\}  Multiples of 12: \{…\}
c. Multiples of 7: {…}  
Multiples of 4: {…} 
d. Multiples of 8: {…}  
Multiples of 4: {…} 
e. Multiples of 2: {…}  
Multiples of 4: {…} 
f. Multiples of 6: {…}  
Multiples of 8: {…} 

4. Determine the LCM using the ladder method (factorising).

Example: Multiples of 12 and 8

<table>
<thead>
<tr>
<th>12</th>
<th>2</th>
<th>8</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

2 × 2 × 2 × 3
= 8 × 3
= 24
The lowest common multiple is 24.

a. Multiples of 22 and 28  
b. Multiples of 38 and 72  
c. Multiples of 32 and 36 

d. Multiples of 74 and 48  
e. Multiples of 27 and 81  
f. Multiples of 68 and 88 

Problem solving

What is the sum of the first 20 numbers that are multiples of both 3 and 5?
5
Highest common factor and lowest common multiple of three-digit numbers

Explain the factor tree and ladder method by using the examples below.

Start by working out whether it is divisible by one of the prime numbers 2, 3, 5, 7, etc.

- If the number ends on an even number it is divisible by 2.
- If the sum of the digits is divisible by 3 the numbers are divisible by 3.
- If the number ends on 0 or 5 it is divisible by 5.

1. Calculate the HCF of two numbers using factorisation or inspection.

Example: Factors of 192 and 216

<table>
<thead>
<tr>
<th>192</th>
<th>2 [2]</th>
<th>216</th>
<th>2 [2]</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>2 [2]</td>
<td>108</td>
<td>2 [2]</td>
</tr>
<tr>
<td>48</td>
<td>2 [2]</td>
<td>54</td>
<td>2 [2]</td>
</tr>
<tr>
<td>24</td>
<td>2 [2]</td>
<td>27</td>
<td>3 [3]</td>
</tr>
<tr>
<td>12</td>
<td>2 [2]</td>
<td>9</td>
<td>3 [3]</td>
</tr>
<tr>
<td>6</td>
<td>2 [2]</td>
<td>3</td>
<td>3 [3]</td>
</tr>
<tr>
<td>3</td>
<td>3 [3]</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

192 = 2 × 2 × 2 × 2 × 2 × 3
216 = 2 × 2 × 2 × 3 × 3 × 3

Common factors are = 2, 2, 2, 3

HCF = 2 × 2 × 2 × 3 = 24

Factor trees

Example: Factors of 192 and 216

I know that 216 can be divided by 3 because 2 + 1 + 6 = 9, and 9 can be divided by 3.

192: 2 \[2\] \[2\] \[2\] \[2\] \[2\] \[3\] = 2 × 2 × 2 × 2 × 2 × 3
216: 2 \[2\] \[2\] \[2\] \[3\] \[3\] \[3\] = 2 × 2 × 2 × 3 × 3 × 3

2. a. 72 and 188

b. 205 and 315

c. 456 and 572
d. 208 and 234
2. Calculate the LCM using factorisation or inspection.

Example: 123 and 141

\[
\begin{array}{ccc}
123 & 141 \\
3 & 3 \\
41 & 47 \\
1 & 1
\end{array}
\]

\[\text{LCM} = 3 \times 41 \times 47 \times 1 = 5781\]

a. 128 and 256
b. 243 and 729
c. 125 and 625
d. 200 and 1000

e. 225 and 675
f. 162 and 486

Problem solving

Explain to a member of your family how you calculate the HCF using factorisation.
Can you still remember the meaning of profit, loss and discount? Do you know the meaning of VAT?

**Profit** is the surplus remaining after total costs are deducted from total revenue.

**Loss** is the excess of expenditure over income.

**Discount** is the amount deducted from the asking price before payment.

VAT (Value Added Tax) is the tax payable on all goods and services in South Africa.

In South Africa the current VAT rate is 14%. Some essential foods are exempt – that means they have a 0% VAT rate.

1. Peter buys 10 apples at R2.50 each. He sells each apple for R4.00. How much profit does he make if he sells 50% of his apples at full price and the rest at a 25% discount?

2. Mandla goes to university for one year. It costs R45 000 for his tuition and residence fees. The university offers him 22% discount based on his good school results. How much does he pay for the year?
Interesting facts: Value Added Tax (VAT) was introduced by the European Economic Community (now the European Union) in the 1970s as a consumption tax. It is a tax on the purchase price levied each stage in the chain of production and distribution from raw materials to the final sale. For the final buyer, it is a tax on the full purchase price. For the seller, it is tax only on the “value added” by the seller to the product, material or service (as the seller claims back the VAT they paid for the product). Most of the cost of collecting the tax is borne by business, rather than by the state. Value Added Taxes were introduced in part because they give sellers a direct financial stake in collecting the tax.

3. Ann buys a computer game for R650 excluding VAT. How much VAT will she pay? How much will she pay in total?

4. Lebo buys blank writable CDs in bulk. He repackages them and sells them individually. He pays R40,00 cash (including VAT) for 50 CDs. He receives a 5% cash discount. For how much must he sell each CD to make a 40% profit?

5. Musa buys a new radio for R125,00 excluding VAT. He pays cash and gets a 5% cash discount. How much will he pay in total including VAT?

Problem solving

Palesato receives R100 per week pocket money. She goes to the cinema twice (cost R30,00 per film excluding VAT). She has coffee for R5,00 and buys R25,00 airtime, both with VAT included. How much pocket money can she carry over to the next week?
Can you still remember what a budget is? What is the most important rule of a budget?

**Budget** is the estimate of revenues and expenditures over a specified period.

Budget isn't a bad word. Budgeting is one of the best keys to good management of your money. Budgeting prevents overspending.

1. You receive R300.00 pocket money every month. You want to go to a movie once a week. The entrance fee is R30.00 and a cold drink is R8.00. The taxi fare is R10.00. Will you be able to go every week? Compile a budget for the month (4 weeks).

2. You had the following expenses last month: Movie R30.00; Taxi R100.00; Ice Cream R9.75; New shirt R45.00; Donation to welfare R50.00; Stationery R65.00; Repairs to your bicycle R175.00. You receive R400 pocket money per month for the chores you do around the house. You have saved R372.00 until now. Complete the budget below to find out if you can save anything or if you will need to use some of your savings?

<table>
<thead>
<tr>
<th></th>
<th>Estimated amount</th>
<th>Actual amount</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Income (pocket money)</strong></td>
<td>400.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Expenses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>75.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Movies</td>
<td>60.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweets</td>
<td>15.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clothes</td>
<td>100.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Donations</td>
<td>65.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Savings</td>
<td>40.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stationary</td>
<td>50.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Estimated total expenses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net Income</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. You plan to start selling flowers to make extra pocket money. A bunch of flowers costs you R65.00 at the market. You need to pay R50 taxi fare for a return trip to the market and your wrapping paper cost you R20.00 for 20 sheets. You only need one sheet per bunch. Use the budget below to calculate what your income for the month must be if you estimate that you can sell 5 bunches per week and you want to make 25% profit. You can only carry 10 bunches at a time in the taxi.

<table>
<thead>
<tr>
<th>Estimated amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income (sales of flowers)</td>
</tr>
<tr>
<td>Expenses</td>
</tr>
<tr>
<td>Flowers</td>
</tr>
<tr>
<td>Wrapping</td>
</tr>
<tr>
<td>Taxi</td>
</tr>
<tr>
<td>Estimated total expenses</td>
</tr>
<tr>
<td>Net Income (profit)</td>
</tr>
</tbody>
</table>

4. Previously Sipho spent R160.00 a week of his weekly allowance of R200.00. Now his allowance has been reduced to only R100.00 a week. Work out a new budget so that he can still do the same things.

Previous expenditure:
- Movies: R25 (×2)
- Airtime: R60 (×1)
- Cold drink: R8 (×4)
- Chips: R3 (×6)

Problem solving

Make a list of 5 ways you can extend your budget. Share this list with the rest of the class.

Remember: Extending your budget means you have to increase your surplus. This does not only mean reducing expenditure, but also increasing income.
Can you still remember what a loan is? What is interest?

**Definition**

A loan is sum of money that an individual or a company lends to an individual or company with the objective of gaining profits when the money is paid back.

**Interest** is the fee charged by a lender to a borrower for the use of borrowed money. The fee is usually expressed as an annual percentage of the amount borrowed, also called interest rate.

Everyone knows the old advice, “Never a borrower or a lender be,” but in the modern world loans and credit have just about replaced cash savings as the way that average people finance large purchases. Therefore make sure you know exactly how much interest you pay.

---

### 1. Find the simple interest earned on a amount of R1 400 at an annual interest rate of 6.5% over 3 years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Amount</th>
<th>Interest Rate</th>
<th>Interest Earned</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>R1 400</td>
<td>6.5%</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

### 2. On 1 June Sipho opened a savings account at the Postbank that paid 4.5% interest. He deposited R600. Ten days later on 10 June he deposited R1 000. Five days later on 15 June he deposited R500. No other deposits or withdrawals were made. Fifteen days later, at the end of the month, the bank calculated the daily interest.

**a.** How much simple interest (calculated to the nearest cent) did he earn?

**b.** What was the balance of the account at the end of the first 30 days?

<table>
<thead>
<tr>
<th>Date</th>
<th>Deposits</th>
<th>Withdrawals</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 June</td>
<td>R600</td>
<td></td>
<td>R600</td>
</tr>
<tr>
<td>10 June</td>
<td>R1 000</td>
<td></td>
<td>R1 600</td>
</tr>
<tr>
<td>15 June</td>
<td>R500</td>
<td></td>
<td>R2 100</td>
</tr>
</tbody>
</table>

---
3. Suzy borrowed R2 400 from a bank for a period of two years and six months at a simple annual interest rate of 4.7%. How much must she repay at the end of the time period?

4. Andile has R1 300 to invest and needs R1 800 in 12 years. What annual rate of return will he need to accomplish his goal?

5. Jabu’s investment of R2 200 earned R528 in two years.
   a. Find the simple interest rate for this investment. If she decides to invest the total amount (original principal amount plus interest) for another two years at the same rate, calculate the following:
   b. What interest will she earn over the second two years.
   c. What is the difference in interest earned over the first two years, compared with interest earned over the second two years?

Problem solving

A total of R24 000 was invested in two accounts. One account earned 8% annual interest and the other earned 9%. The total annual interest earned was R2 020. How much was invested in each account? Write two equations to help you solve the problem.
Do you know what hire purchase means?

**Hire purchase** is a system by which a buyer pays for an asset in regular instalments, while enjoying the use of it. During the repayment period, ownership of the item does not pass to the buyer (it is on ‘hire’). Upon the full payment of the loan plus interest, the title passes to the buyer (the ‘purchase’ is now complete).

Many organisations enter into hire purchase for leasing agreements to pay for and use equipment over a period of time rather than paying the full cost up front. The repayment period is normally the same as the production life of the machine. For example: a farmer buys a tractor and pays it off over 5 years. After 5 years he typically has to replace the tractor.

Hire purchase must not be confused with instalment sale.
In North America and the United Kingdom they call hire purchases, instalment sales, but in South Africa an instalment sale refers to the finance of an asset that is similar to a loan. In the case of an instalment sale the buyer borrows the money from an institution (such as a bank) and uses the equipment as surety. Ownership of the item is transferred to the buyer immediately. In the case of a hire purchase the institution buys the equipment and ownership belongs to the institution. The buyer ‘hires’ the equipment from the institution at an agreed instalment. Only at the end of the hire purchase agreement is ownership transferred to the buyer.

1. **How to calculate hire purchase payments**

   a. Determine the total cost of the item you wish to purchase including the VAT (value added tax) and any other charges or fees that may apply. These may include accounting, insurance, and transport charges, among others.

   b. Subtract the amount of your down payment (initial deposit towards the expense) from the total cost. Your payments are based on the total cost minus the down payment.

   c. Ask what the interest rate is and how it is calculated. Some interest rates are offered at a flat rate (simple interest), while others are calculated periodically on the balance remaining (compound interest).

   d. Calculate hire purchase payments based on the amount you owe, the interest rate and payment schedule. This could amount to an equal payment throughout the course of your payment schedule, or it could mean varying amounts.
2. James buys a gas grill for his restaurant on hire purchase. The grill costs R7 800 and he pays a deposit of R1 000. What will his instalment be if he pays 12 % p.a. simple interest and repays over a period of 18 months?

3. Mandla, a farmer, wants to buy a new tractor. The tractor costs R160 000 excluding VAT. He can pay a deposit of R20 000. He decides to buy the tractor on hire purchase over 60 months at a simple interest rate of 10 %.
   a. What will his instalment be?
   b. How much interest will he pay?
   c. How much will he pay in total for the tractor over 60 months?

Problem solving

David buys a new car on hire purchase. The car costs R65 000 (excluding VAT) and he trades in his old car (that was fully paid for) for R7 500. The car registration, documentation and licence fees were R2 500. What will his instalment be if he pays 7 % p.a. in simple interest and repays over a period of 54 months?
Do you know what exchange rate means?

An **exchange rate** is the current market price for which one currency can be exchanged for another.

The **Rand** (sign: R; code: ZAR) is the currency of South Africa.

The **United States Dollar** (sign: $; code: USD; also abbreviated US$) is the official currency of the United States of America.

The **Euro** (sign: €; code: EUR) is the official currency of the Euro zone.

The **Pound sterling** (symbol: £; code: GBP), commonly called the Pound, is the official currency of the United Kingdom.

Quotes using a country’s home currency as the price currency (e.g., EUR 0.735342 = USD 1.00 in the euro zone) are known as direct quotation or price quotation (from that country’s perspective) and are used by most countries.

Quotes using a country’s home currency as the unit currency (e.g., EUR 1.00 = USD 1.35991 in the euro zone) are known as indirect quotation.

Use the exchange rates in the table to help you solve the word problems. Show your work in the space provided.

<table>
<thead>
<tr>
<th></th>
<th>ZAR (£)</th>
<th>USD ($)</th>
<th>GBP (£)</th>
<th>CAD ($)</th>
<th>EUR (£)</th>
<th>AUD ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZAR</td>
<td>1.00</td>
<td>6.76</td>
<td>11.06</td>
<td>6.89</td>
<td>9.88</td>
<td>7.17</td>
</tr>
<tr>
<td>USD</td>
<td>0.15</td>
<td>1.00</td>
<td>1.60</td>
<td>0.92</td>
<td>1.46</td>
<td>0.87</td>
</tr>
<tr>
<td>GBP</td>
<td>0.09</td>
<td>1.09</td>
<td>1.00</td>
<td>0.58</td>
<td>0.91</td>
<td>0.55</td>
</tr>
<tr>
<td>CAD</td>
<td>0.15</td>
<td>1.09</td>
<td>1.74</td>
<td>1.00</td>
<td>1.59</td>
<td>0.95</td>
</tr>
<tr>
<td>EUR</td>
<td>0.10</td>
<td>0.69</td>
<td>1.10</td>
<td>0.63</td>
<td>1.00</td>
<td>0.60</td>
</tr>
<tr>
<td>AUD</td>
<td>0.14</td>
<td>1.15</td>
<td>1.83</td>
<td>1.05</td>
<td>1.67</td>
<td>1.00</td>
</tr>
</tbody>
</table>

1. Mbali earned R100 from waitressing. The new body board she wants to buy costs $12 AUD. After her purchase, how much money will she have left in ZAR?
2. Jack lives in Ottawa, Ontario, Canada. His uncle lives in London, England. For his birthday, Jack received £20 from his uncle. How many Canadian dollars can he buy with his birthday money?

3. Olivia lives in Sydney, Australia. Her grandmother lives in Paris, France. For Christmas, she received €40 from her grandmother. How many Australian dollars can she buy with her Christmas money?

4. Mandla has $11 USD. The computer game he wants to buy costs $10 AUD. Does he have enough money to buy the game? If not, how much more US money does he need?

Problem solving

Jabu has €35. She wants to purchase jeans for $25 CAD and a T-shirt for $15 CAD. After her purchases, how much ZAR will she have left in ZAR?
Sequences that involve integers

Think about what you know about integers. Look at these integers. Which integers come before and after each number?

Integers include the counting numbers \{1, 2, 3, \ldots\}, zero \{0\}, and the negative of the counting numbers \{-1, -2, -3, \ldots\}

Place the integers above in ascending and then descending order.

1. Complete these number lines.
   a.  
   
      \[ -9 \quad 10 \quad -1 \quad -12 \]
   
      \[ 1 \quad -7 \quad -2 \quad -15 \]

   b.  
   
   c.  
   
   d.  

2. Complete these number lines. We have given you the integers for the first value and the last value of the intervals you are to show on each number line.
   a. \(-5\) and \(1\)

   b. \(-2\) and \(6\)

   c. \(-10\) and \(-3\)

   d. \(-100\) and \(0\)

3. Complete the following.
   a. \(-8\) \(\rightarrow\) \(-6\) \(\rightarrow\) \(-4\)

   b. \(-64\) \(\rightarrow\) \(-56\) \(\rightarrow\) \(-48\)

   c. \(-50\) \(\rightarrow\) \(-45\) \(\rightarrow\) \(-42\) \(\rightarrow\) \(-42\) \(\rightarrow\) \(-66\)
4. Identify the last term in each pattern. What is the rule?

Example: –8, –7, –6, –5, –4, –3, –2, The last term (–2) is the 7th term in the pattern. The rule is previous number + 1.

a. –7, –6, –5, –4, –3, –2, 0, 1 th term. ____________
   b. –20, –18, –16, –14, –12, –10, th term. ____________
   c. –25, –16, –9, –4, –1 th term. ____________

5. Circle the fifth term in each pattern. What is the rule?

a. –8, –6, –4, –2, 0, 2, 4, 6, 8
   b. –15, –12, –9, –6, –3, 0, 3, 6

6. Determine the 10th term in each pattern. What is the rule?

a. –10, –9, –8, th term. ____________
   b. –28, –26, –24, th term. ____________
   c. –31, –28, –25, th term. ____________
   d. –99, –94, –89, ____________
   e. –82, –78, –74, ____________
   f. –84, –77, –70, ____________

7. Write the following in ascending order:

a. 6, –4, 2, –2, 0, –6
   b. –8, 0, 8, –24, 16, –16, 24
   c. –5, 5, 15, 55, 10, –15, –10, –55
d. –100, –50, –200, –150, 0, –300

8. Fill in <, > or =

a. 4 _______ –4
   b. –18 _______ –8
   c. –2 _______ 2
   d. –3 _______ 3
   e. –10 _______ 10
   f. –26 _______ –62

Problem solving

The rule for a number sequence is plus five.
Using this rule, make a ten–term sequence including positive and negative integers.
Calculations with multiple operations

BODMAS stands for:
B = 
O = 
D = 
M = 
A = 
S = 

What do you notice?
(-3 - 2) \times (7 - 2) = -5 \times 5 = -25
(-3 - 2) \times (7 - 2) = -3 - 2 \times 7 - 2 = -3 - 14 - 2 = -19

Which one is correct? Why?
Try it on a normal calculator and then on a scientific calculator. What do you notice?

1. Calculate the following:

Example: (-7) + (5)
= -7 + 5
= -2

a. (-2) + (-3) = 

b. (2) - (-3) = 

c. (-6) - (8) = 

d. (-8) + (-4) = 

e. (4 + 2) + (8 - 3) = 

f. (6 - 8) + (3 + 4) = 

2. Solve the following:

Example: \((-5 - 4) \times (6 - 2)\)
\[\begin{align*}
\text{a. } (2 + 3) \times (4 \times 2) & = \phantom{0} \\
\text{b. } (-2 + 3) \times (-4 + 2) & = \phantom{0} \\
\text{c. } (2 - 3) \div (4 - 2) & = \phantom{0} \\
\text{d. } (-2 - 3) \div (-4 - 1) & = \phantom{0} \\
\text{e. } (5 + 6) \times (8 + 7) & = \phantom{0} \\
\text{f. } (5 - 6) \times (8 - 7) & = \phantom{0}
\end{align*}\]

3. Solve the following:

Example: \( (-3 + 2) + (5 - 3) \times (8 - 9) \)
\[\begin{align*}
\text{a. } (-6 + 8) + (-3 - 4) \times (7 - 9) & = \phantom{0} \\
\text{b. } (-9 + 4) - (-6 + 5) \times (-3 + 2) & = \phantom{0} \\
\text{c. } (6 - 5) \times (-3 + 9) \div (3 + 3) & = \phantom{0} \\
\text{d. } (-7 + 5) \times (-2 - 7) + (-5 + 3) & = \phantom{0} \\
\text{e. } (-9 + 5) \div (-6 +4) - (10 - 11) & = \phantom{0} \\
\text{f. } \text{Create a number sentence. Solve it.} & = \phantom{0}
\end{align*}\]

**Problem solving**

If the answer is 20 and the calculation has three operations, give an example of what the calculation could be.
Properties of numbers and integers

1. Commutative property: use the example to guide you to solve the following:

   Example: \(8 + (-3) = (-3) + 8 = 5\)  \(8 \times (-3) = (-3) \times 8 = -24\)

   a. \(4 + (-2) = \)  \(=\)
   b. \(6 + (-4) = \)  \(=\)
   c. \(10 + (-2) = \)  \(=\)
   d. \(33 + (-14) = \)  \(=\)
   e. \(7 \times (-6) = \)  \(=\)
   f. Make your own sum.

2. Use subtraction to check addition or vice versa.

   Example: \(8 + (-3) = 5\) then
   5 - 8 = -3 or
   5 - (-3) = 8

   a. \(6 + (-2) = \)  then
   b. \(8 + (-9) = \)  then
   c. \(3 + (-2) = \)  then
   d. \(17 + (-8) = \)  then
   e. \(9 + (-5) = \)  then
   f. Make your own sum
3. Associative property: use the example to guide you to calculate the following:

**Example:** \([-(-6) + 4] + (-1) = (-6) + [4 + (-1)] = -3\]

a. \([-3 + 2] + (-4) = \]

b. \([-6] + 7 + (-8) = \]

c. \([13 + (-3)] + (-2) = \]

d. \([-4 + (-10)] + 5 = \]

e. \([-12 + (-9)] + 18 = \]

4. Use division to check or vice versa.

**Example:** \(5 \times (-6) = -30\) then
\[-30 \div 5 = -6\] and
\[-30 \div (-6) = 5\]

a. \(8 \times (-3) = \]
b. \((-7) \times (9) = \]
c. \(5 \times (-7) = \]
d. \(6 \times (-8) = \]
e. \(4 \times (-2) = \]

5. Complete the pattern.

**Example:**
\[(+5) \times (+5) = 25\]
\[(-5) \times (-5) = 25\]
\[(+5) \times (-5) = -25\]
\[(-5) \times (+5) = -25\]

a. \((+2) \times (+2) = \]
b. \((+1) \times (+1) = \]
c. \((-12) \times (-12) = \]
d. \((-2) \times (-2) = \]
e. \((1) \times (-1) = \]
f. \((12) \times (12) = \]

d. \((-7) \times (+7) = \]
e. \((-4) \times (-4) = \]
f. \((-5) \times (+5) = \]

g. \((+7) \times (+7) = \]
e. \((-4) \times (+4) = \]
f. \((-5) \times (+5) = \]

**Problem solving**

If the answer is \(-30\) and the calculation has three operations, what could the calculation be?
Square numbers, cube numbers and more exponents

Write your definition of square numbers. Make a drawing.

Square numbers:

\[ 2 = 2^1 = 2 \]
\[ 2 \times 2 = 2^2 = 4 \]
\[ 2 \times 2 \times 2 = 2^3 = 8 \]
\[ 2 \times 2 \times 2 \times 2 = 2^4 = 16 \]

What will the 10th term be in the pattern?

---

1. Revision: calculate the following:

**Example:**

\[ 5^2 = 5 \times 5 = 25 \]

<table>
<thead>
<tr>
<th>a. 2²</th>
<th>b. 7²</th>
<th>c. 4²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>d. 6²</th>
<th>e. 10²</th>
<th>f. 9²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Revision: calculate the following:

**Example:**

\[ 4^3 = 4 \times 4 \times 4 = 64 \]

<table>
<thead>
<tr>
<th>a. 2³</th>
<th>b. 1³</th>
<th>c. 4³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>d. 3³</th>
<th>e. 3³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Revision: calculate the following using a calculator:

**Example:**

\[ 11^3 = 11 \times 11 \times 11 = 1331 \]

<table>
<thead>
<tr>
<th>a. 17³</th>
<th>b. 14³</th>
<th>c. 16³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>d. 6³</th>
<th>e. 7³</th>
<th>f. 8³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Write these numbers in exponential form:
   Example: $144 = 12 \times 12$
   $= 12^2$
   a. 64
   b. 9
   c. 25
   d. 100
   e. 36
   f. 4

5. Write these numbers in exponential form:
   Example: $81 = 3 \times 3 \times 3 \times 3 = 3^4$
   a. 27
   b. 8
   c. 125

6. Write the following in exponential form:
   Example: $64 + 8$
   $= 8^2 + 2^3$
   $= 2^6 + 2^3$
   a. $125 + 25 = $
   b. $64 + 125 = $
   c. $1 + 9 = $
   d. $1 + 81 = $
   e. $25 + 36 = $

7. Write the following in exponential form.
   Example: $50 \times 50 \times 50 \times 50 \times 50 \times 50 = 50^7$
   a. $30 \times 30 \times 30 \times 30 = $
   b. $40 \times 40 \times 40 \times 40 \times 40 \times 40 \times 40 = $
   c. $60 \times 60 \times 60 = $
   d. $70 \times 70 \times 70 \times 70 \times 70 \times 70 = $
   e. $90 \times 90 \times 90 = $
   f. $200 \times 200 \times 200 = $

8. Look at the examples and calculate:
   Example: $3^1 = 3$, $25^1 = 25$, $m^1 = m$, $9^1 = 9$
   a. $x^1 = $
   b. $a^2 = $
   c. $250^1 = $
   d. $12^1 = $
   e. $7^1 = $
   f. $47^1 = $

### Problem solving
Add the first 10 square numbers.
If the first pattern is 1, the second pattern is 4, and the third pattern is 9, what will the tenth pattern be?

1. Complete the table:

<table>
<thead>
<tr>
<th>Number</th>
<th>Square the number</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 6</td>
<td>(6^2 (6 \times 6))</td>
<td>36</td>
</tr>
<tr>
<td>b. 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. 11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. 16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. 21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. 34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. 48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. 57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Without calculating, say whether the answer will be a positive or negative number.

Example:

\((-15)^2\) will be positive since \((-15) \times (-15) = 225\)

\((15)^2\) will be positive since \((+15) \times (+15) = 225\)

a. \((-9)^2\)  
b. \((18)^2\)  
c. \((19)^2\)  
d. \((-21)^2\)

3. Write in exponential form:

Example:

\(\frac{a \times b \times a \times b}{a^2 \times b^2}\)  

\(\frac{b^2 \times c \times c \times b^2}{b^4 \times c^4}\)

a. \(g \times g \times g \times g \times g\)  
b. \(a \times a \times b \times b\)

c. \(z \times z \times c \times c \times c\)  
d. \(d \times s \times s \times d \times s\)
4. Revision. Calculate the square root.

Example: \( \sqrt{256} \)
\[
= \sqrt{2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2}
= \sqrt{2 \times 2}
= 16
\]

<p>| | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>256</td>
<td>2</td>
<td>128</td>
<td>2</td>
<td>64</td>
<td>2</td>
<td>32</td>
<td>2</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test your answer: \( 16 \times 16 = 256 \)

5. Calculate the square root using the example to guide you:

Example: \( \sqrt{256} \)
\[
= \sqrt{2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2}
= \sqrt{2 \times 2}
= 16
\]

a. \( \sqrt{64} \)  

b. \( \sqrt{25} \)  

c. \( \sqrt{1} \)  

d. \( \sqrt{81} \)  

e. \( \sqrt{49} \)  

You use the rules of divisibility.

Remember this is what we call prime factorisation.

How do you know to start dividing by 2?
You should always try the smallest prime number first.

But how will I know whether the number is divisible by 2 or 3 or 5 etc.

Problem solving

Add together the first 10 cube numbers.
Representing square roots

How quickly can you calculate the lengths of the sides of these square rooms? You may use a calculator.

9 m²  144 m²  529 m²

1. Say whether the following are true or false. Make any false statements true.
   a. $\sqrt{72} = 7$
   b. $\sqrt{72} = 49$
   c. $\sqrt{16 + 9} = 25$
   d. $\sqrt{16 + 9} = 5$
   e. $\sqrt{62} = 36$
   f. $\frac{\sqrt{16}}{9} = \frac{4}{3}$

2. Revise: calculate.

   Example: $\sqrt{12 \cdot 12} = 12$

   Note: We have used the • symbol for multiplication, instead of the usual ×, to save space.

   a. $\sqrt{2 \times 2}$
   b. $\sqrt{3 \times 3}$
   c. $\sqrt{4 \times 4}$
   d. $\sqrt{5 \times 5}$
   e. $\sqrt{6 \times 6}$
   f. $\sqrt{8 \times 8}$
   g. $\sqrt{10 \times 10}$
   h. $\sqrt{7 \times 7}$
   i. $\sqrt{9 \times 9}$
   j. $\sqrt{11 \times 11}$

3. Represent the square root differently (with numbers that are not square numbers).

   Example 1: $\sqrt{2 \times 2} = \sqrt{2} \times \sqrt{2}$
   $= 2 \times 2$
   $= 2 \times \sqrt{2}$

   Example 2: $\sqrt{2 \times 2 \times 2} = \sqrt{2} \times \sqrt{2} \times \sqrt{2}$
   $= 2 \times 2 \times \sqrt{2}$
   $= 2^2 \sqrt{2}$
1. Look at the example and complete the following:

Example: \(3^2 = 9\) therefore \(\sqrt{9} = 3\)

a. \(5^2\)  
   b. \(9^2\)  
   c. \(7^2\)  

da. \(2^2\)  
   e. \(100^2\)  
   f. \(\sqrt{36}\)  

g. \(\sqrt{81}\)  
   h. \(\sqrt{625}\)  
   i. \(\sqrt{1}\)  

j. \(\frac{3}{\sqrt{8}}\)

k. Write down what you did. Share it with a family member.

2. Represent the square root differently.

Example: \(\sqrt{8} = \sqrt{2 \times 2 \times 2} = 2 \times \sqrt{2}\)

a. \(\sqrt{12}\)  
   b. \(\sqrt{45}\)  
   c. \(\sqrt{28}\)  

da. \(\sqrt{20}\)  
   e. \(\sqrt{24}\)  
   f. \(\sqrt{18}\)  

3. Problem solving

Represent the square root of any four-digit number using prime factorisation.
Cube numbers and roots

If the first step in the pattern is 1, the second step in the pattern is 8 and the third step is 27, what is the tenth step in the pattern?

1. Complete the table.

<table>
<thead>
<tr>
<th>Number</th>
<th>Cube the number</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 2</td>
<td>2³ = (2 × 2 × 2)</td>
<td>8</td>
</tr>
<tr>
<td>b. 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. 12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Answer positive or negative without calculating.

Example: 
(-3)³ is negative because (-3) × (-3) × (-3) = -27
(3)³ is positive because (+3) × (+3) × (+3) = 27

a. (4)³
b. (16)³
c. (-9)³
d. (27)³
e. (-13)³
f. (-6)³
3. Write in exponential form.

Example 1: \( a \times a \times a \times b \times b \times b \)

\[ = a^3 \times b^3 \]

Example 2: \( 4 \times 4 \times m \times m \times m \)

\[ = 4^3 \times m^3 \]

\[ = 64m^3 \]

a. \( b \times b \times b \times m \times m \times m \)

b. \( 3 \times 3 \times 3 \times 3 \times c \times c \)

c. \( 2 \times 2 \times 2 \times n \times n \times n \times n \times n \)

d. \( m \times m \times m \times n \times n \times n \)

e. \( 4 \times 4 \times 4 \)

4. Calculate.

Example:

\[ \sqrt[3]{27} \]

\[ = \sqrt[3]{3 \times 3 \times 3} \]

\[ = 3 \]

a. \( \sqrt[3]{125} \)

b. \( \sqrt[3]{64} \)

c. \( \sqrt[3]{1} \)

d. \( \sqrt[3]{8} \)

e. \( \sqrt[3]{0} \)

5. Calculate the cube root using the example to help you.

Example:

\[ \sqrt[3]{729} \]

\[ = \sqrt[3]{3 \times 3 \times 3 \times 3 \times 3 \times 3} \]

\[ = 3 \times 3 \]

\[ = 9 \]

Is 729 divisible by 3?
Yes, 7 + 2 + 9 = 18, 18 is divisible by 3

a. 216

b. 19 683

Problem solving

Calculate the cube root of any four digit number using prime factorisation.
Representing cube roots

What is the length, height and width of these cubes?

- 8 m³
- 64 m³
- 216 m³

1. Say whether the following are true or false:
   a. \(\sqrt[3]{27} = 3\)  
   b. \(\sqrt[3]{73} = 49\)  
   c. \(\sqrt[3]{2} = 2\)  
   d. \(\sqrt[3]{27} = 3\)  
   e. \(\sqrt[3]{9} = 3\)

2. Revise: calculate.

   **Example:** \(\sqrt[3]{12 \times 12 \times 12} = 12\)

   a. \(\sqrt[3]{10 \times 10 \times 10}\)  
   b. \(\sqrt[3]{5 \times 5 \times 5}\)
   c. \(\sqrt[3]{3 \times 3 \times 3}\)  
   d. \(\sqrt[3]{11 \times 11 \times 11}\)
   e. \(\sqrt[3]{7 \times 7 \times 7}\)  
   f. \(\sqrt[3]{4 \times 4 \times 4}\)

3. Calculate.

   **Example:** \(\sqrt[3]{8 \times 2}\)
   \[= \sqrt[3]{2 \times 2 \times 2 \times 2} = \sqrt[3]{2} \times \sqrt[3]{2} = 2 \times \sqrt[3]{2} = 2 \times 2\)

   a. \(\sqrt[3]{9 \times 3}\)  
   b. \(\sqrt[3]{25 \times 5}\)
Find a three-digit cube number that is between 500 and 600.
19
Scientific notation

Read the following:

I need to write this number every day: 200 000 000.

You can write it as: 2 × 10^{11}

How did you do that?

Let me show you.

Write the last speech bubble for this conversation.

1. Complete the following, using the example to guide you:

Example

10 × 10 × 10 × 10 × 10
= 10 000 000
= 10^7

a. 10 × 10 =

b. 10 × 10 × 10 × 10 =

c. 10 × 10 × 10 × 10 × 10 × 10 =

d. 10 × 10 × 10 × 10 × 10 × 10 × 10 =

e. 10 × 10 × 10 =

2. Write as a natural number:

a. 10^6

b. 10^4

c. 10^8

d. 10^3

e. 10^5
3. Write the following numbers in scientific notation:

**Example:** \( 76\,430\,202 \)
\( = 7,6430202 \times 10^7 \)

<table>
<thead>
<tr>
<th>Number</th>
<th>Scientific Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 2,567,389</td>
<td>( 2.567389 \times 10^6 )</td>
</tr>
<tr>
<td>b. 32,876,843</td>
<td>( 3.2876843 \times 10^6 )</td>
</tr>
<tr>
<td>c. 35,784,321</td>
<td>( 3.5784321 \times 10^6 )</td>
</tr>
<tr>
<td>d. 99,999,999</td>
<td>( 9.9999999 \times 10^6 )</td>
</tr>
<tr>
<td>e. 126,589,543</td>
<td>( 1.26589543 \times 10^7 )</td>
</tr>
<tr>
<td>f. 101,101,101</td>
<td>( 1.01101101 \times 10^6 )</td>
</tr>
</tbody>
</table>

4. Write the following in standard notation:

**Example:** \( 7.6430202 \times 10^7 \)
\( = 76\,430\,202 \)

<table>
<thead>
<tr>
<th>Number</th>
<th>Standard Notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 7,834561 \times 10^6</td>
<td>( 7,834,561 \times 10^6 )</td>
</tr>
<tr>
<td>b. 8,4762 \times 10^4</td>
<td>( 8,476,200 \times 10^4 )</td>
</tr>
<tr>
<td>c. 8,99945671 \times 10^8</td>
<td>( 8,999,456,710 \times 10^8 )</td>
</tr>
<tr>
<td>d. 9,9345678 \times 10^7</td>
<td>( 9,934,567,800 \times 10^7 )</td>
</tr>
<tr>
<td>e. 5,8384567 \times 10^7</td>
<td>( 5,838,456,700 \times 10^7 )</td>
</tr>
<tr>
<td>f. 11,34529 \times 10^5</td>
<td>( 11,345,290 \times 10^5 )</td>
</tr>
</tbody>
</table>

**Problem solving**

Write a number sentence, using scientific notation, for one hundred thousand plus one million multiplied by ten to the power of two.
### Laws of exponents: $x^m \times x^n = x^{m+n}$

The exponent of a number says how many times to use the number in a multiplication. E.g. $2^3 = 2 \times 2 \times 2$

An exponent is an easy way to write a lot of multiples.

The laws of exponents are also called the laws of powers or indices. What do you think this means? In this worksheet you will learn that $x^m \times x^n = x^{m+n}$

1. Solve.

<table>
<thead>
<tr>
<th><strong>Example:</strong></th>
<th><strong>Test:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>$2^3 \times 2^2$</td>
<td>$2^3 \times 2^2$</td>
</tr>
<tr>
<td>$= 2^{3+2}$</td>
<td>$= 8 \times 4$</td>
</tr>
<tr>
<td>$= 2^5$</td>
<td>$= 32$</td>
</tr>
<tr>
<td>$= 32$</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>a.</strong></th>
<th><strong>b.</strong></th>
<th><strong>c.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>$3^3 \times 3^7 =$</td>
<td>$9^4 \times 9^2 =$</td>
<td>$1^9 \times 1^9 =$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>d.</strong></th>
<th><strong>e.</strong></th>
<th><strong>f.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^2 \times 10^6 =$</td>
<td>$7^2 \times 7^3 =$</td>
<td>$8^5 \times 8^9 =$</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

You can use a calculator.
2. Simplify and test your answer.

<table>
<thead>
<tr>
<th>Example:</th>
<th>Test your answer: $x = 2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x^3 \times x^4$</td>
<td>$2^3 \times 2^4$</td>
</tr>
<tr>
<td></td>
<td>$= x^{3+4}$</td>
</tr>
<tr>
<td></td>
<td>$= 8 \times 16$</td>
</tr>
<tr>
<td></td>
<td>$= 128$</td>
</tr>
</tbody>
</table>

a. $c^2 \times c^4 = $  
   test with $c = 2$

b. $m^4 \times m^5 = $  
   test with $m = 3$

c. $p^7 \times p^3 = $  
   test with $p = 2$

d. $q^3 \times q^7 = $  
   test with $q = 3$

e. $x^5 \times x^8 = $  
   test with $x = 4$

f. $s^9 \times s^2 = $  
   test with $s = 5$

3. Why can we say: $a^m \times a^n = a^{m+n}$? Give three examples.

a. 

b. 

c. 

Problem solving

If the answer is $a^{4+2}$, write a sum and the rule for the answer.
Can you still remember what the answer for this law of exponents is?

\[ x^m \times x^n = \quad \]  

Today we are going to learn that:

\[ \frac{x^m}{x^n} = x^{m-n} \quad \text{or} \quad x^m \div x^n = x^{m-n} \]

1. Simplify.

**Example:**

\[ 3^5 \div 3^2 = \]

\[ = 3^{5-2} \]

\[ = 3^3 \]

\[ = 27 \]

**Test:**

\[ 3^5 \div 3^2 = 243 \div 9 = 27 \]

You can use a calculator.

a. \[ 7^5 \div 7^2 = \]

b. \[ 3^{10} \div 3^7 = \]

c. \[ 2^9 \div 2^3 = \]

d. \[ 8^{12} \div 8^8 = \]

e. \[ 1^{10} \div 1^{10} = \]

f. \[ 4^{15} \div 4^4 = \]
2. Solve and test your answer.

Example: \( \frac{x^5}{x^3} \)

\[ = x^{5-3} \]

\[ = x^2 \]

Test your answer: \( x = 2 \)

\[ \frac{2^5}{2^3} \]

\[ = 2^{5-3} \]

\[ = 2^2 \]

\[ = 4 \]

\[ \frac{2^3}{2^3} = 2^{3-3} \]

a. \( p^5 \div p^3 = \)

Test with \( p = 2 \)

b. \( z^7 \div z^4 = \)

Test with \( z = 3 \)

c. \( e^8 \div e^3 = \)

Test with \( e = 2 \)

d. \( x^7 \div x^4 = \)

Test with \( x = 3 \)

e. \( s^9 \div s^5 = \)

Test with \( s = 2 \)

f. \( g^{20} \div g^{15} = \)

Test with \( g = 3 \)

Problem solving

If the answer is \( e^{b-d} \), write a sum for it.
More laws of exponents: $(x^m)^n = x^{mn}$

Revise the following:

\[
x^m \times x^n = \\
x^m \div x^n = \\
\]

Today we are going to learn that:

\[
(x^m)^n = x^{mn}
\]

1. Simplify.

Example:

\[
(2^3)^2 = 2^{3\times2} = 2^6 = 64
\]

Test:

\[
(2^3)^2 = (8)^2 = 64
\]

\[
\begin{align*}
\text{a.} & \quad (2^2)^7 \\
\text{b.} & \quad (14)^1 \\
\text{c.} & \quad (7^9)^4 \\
\text{d.} & \quad (3^5)^2 \\
\text{e.} & \quad (15^2)^5 \\
\text{f.} & \quad (12^7)^{11}
\end{align*}
\]

2. Simplify.

Example:

\[
(x^3)^2 = x^{3\times2} = x^6
\]

Test your answer: $x = 2$

\[
(2^3)^2 = (8)^2 = 64 \quad \text{and} \quad 2^{3\times2} = 2^6 = 64
\]

\[
\begin{align*}
\text{a.} & \quad (x^2)^3 \\
\text{b.} & \quad (p^2)^6 \\
\text{c.} & \quad (p^5)^5 \\
\text{d.} & \quad (a^2)^3 \\
\text{e.} & \quad (x^3)^4 \\
\text{f.} & \quad (v^3)^3
\end{align*}
\]
3. Solve.

Example:
\[(3x^2)^3\]
\[= 3^1 \times x^{2\cdot3}\]
\[= 3^3 \times x^6\]
\[= 27x^6\]

a. \((2e^4)^1\)

b. \((4g^3)^5\)

c. \((9f^6)^6\)

d. \((10k^8)^4\)

e. \((23e^{10})^2\)

f. \((14f^5)^3\)

4. Solve.

Example:
\[(a \times t)^n\]
\[= a^n \times t^n\]

a. \((r \times s)^4\)

b. \((b \times c)^r\)

c. \((x \times y)^t\)

d. \((a \times d)^n\)

e. \((a \times c)^k\)

f. \((e \times g)^k\)

Problem solving

If the answer is \(a^r \times b^r\), write a sum for the answer.
Laws of exponents: \((x^0) = 1\)

Revise the following:

\[
\begin{align*}
    x^m \cdot x^n &= \quad \\
    x^m \div x^n &= \quad \\
    (x^m)^n &= \quad 
\end{align*}
\]

Today we are going to learn that:

\((x^0) = 1\)

1. Solve: what will each number to the power of 0, 1, 2 and 3 be?

Example:

\[
\begin{array}{cccc}
    3^0 & 3^1 & 3^2 & 3^3 \\
    = 1 & = 3 & = 9 & = 27 \\
\end{array}
\]

a. 12 

\[
\begin{array}{c}
    = 1 \\
\end{array}
\]

b. 8 

\[
\begin{array}{c}
    = 3 \\
\end{array}
\]

c. 4 

\[
\begin{array}{c}
    = 9 \\
\end{array}
\]

d. 13 

\[
\begin{array}{c}
    = 27 \\
\end{array}
\]

e. 9 

\[
\begin{array}{c}
    \text{You can use a calculator.} \\
\end{array}
\]

f. 7 

\[
\begin{array}{c}
    \text{You can use a calculator.} \\
\end{array}
\]

2. Solve: what will each number to the power of 0 and 1 be?

Example:

\[
\begin{align*}
    a^0 &= 1 \\
    a^1 &= a \\
\end{align*}
\]

a. \(x\) 

\[
\begin{array}{c}
    \text{You can use a calculator.} \\
\end{array}
\]

b. \(q\) 

\[
\begin{array}{c}
    = 1 \\
\end{array}
\]

c. \(r\) 

\[
\begin{array}{c}
    = a \\
\end{array}
\]

d. \(m\) 

\[
\begin{array}{c}
    \text{You can use a calculator.} \\
\end{array}
\]

e. \(p\) 

\[
\begin{array}{c}
    \text{You can use a calculator.} \\
\end{array}
\]

f. \(y\) 

\[
\begin{array}{c}
    \text{You can use a calculator.} \\
\end{array}
\]
3. Simplify

Example:
\[(4x^2)^0 = 1\]

<table>
<thead>
<tr>
<th>a. [(6x^7)^0]</th>
<th>b. [(4y^3)^0]</th>
<th>c. [(7k^8)^0]</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

d. \[(9t^6)^0\]  
e. \[(8s^{10})^0\]  
f. \[(13p^{10})^0\]  

4. Simplify using both methods.

Example:
\[a^4 ÷ a^4 = \frac{a \times a \times a \times a}{a \times a \times a \times a} = 1\]
\[a^4 \text{ means } a \times a \times a \times a = a^4\]
\[a^0 = a^{4-4} = a^0 = 1\]

<table>
<thead>
<tr>
<th>a. [a^6 ÷ a^6]</th>
<th>b. [v^3 ÷ v^3]</th>
<th>c. [m^3 ÷ m^3]</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>

d. \[w^2 ÷ w^2\]  
e. \[y^7 ÷ y^7\]  
f. \[z^{10} ÷ z^{10}\]  

Problem solving

If the answer is 1, write a sum and the rule for the answer.
Calculations with exponents

Write down 3 examples of each of these.

<table>
<thead>
<tr>
<th>Square number</th>
<th>Square root</th>
<th>Cube number</th>
<th>Cube root</th>
</tr>
</thead>
</table>

1. Calculate the following:

**Example:** 
\((-6^2)\)  
\[= - (6 \times 6)\]  
\[= -36\]

<table>
<thead>
<tr>
<th>a. ((-8^2))</th>
<th>b. ((7^2))</th>
<th>c. ((-9^2))</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>d. ((-10^2))</th>
<th>e. ((6^2))</th>
<th>f. ((-11^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

2. Calculate the following:

**Example:** 
\((-6^3)\)  
\[= - (6 \times 6 \times 6)\]  
\[= -216\]

<table>
<thead>
<tr>
<th>a. ((-3^3))</th>
<th>b. ((1^3))</th>
<th>c. ((-9^3))</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>d. ((2^3))</th>
<th>e. ((-7^3))</th>
<th>f. ((-10^3))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Calculate the following:

Example: \( \sqrt{-9} \)
\[
= -\sqrt{3 \times 3} \\
= -3
\]

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ( \sqrt{-36} )</td>
<td>b. ( \sqrt{-49} )</td>
<td>c. ( \sqrt{-16} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. ( \sqrt{81} )</td>
<td>e. ( \sqrt{4} )</td>
<td>f. ( \sqrt{64} )</td>
</tr>
</tbody>
</table>

4. Calculate the following:

Example: \( \sqrt[3]{-8} \)
\[
= -2
\]

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ( \sqrt[3]{8} )</td>
<td>b. ( \sqrt[3]{-27} )</td>
<td>c. ( \sqrt[3]{-125} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. ( \sqrt[3]{64} )</td>
<td>e. ( \sqrt[3]{125} )</td>
<td>f. ( \sqrt[3]{-64} )</td>
</tr>
</tbody>
</table>

**Problem solving**

Square negative fifteen.
## Calculations with multiple operations
(square and cube numbers, square and cube roots)

### Revision: What does BODMAS mean? Write it down

<table>
<thead>
<tr>
<th>B</th>
<th>O</th>
<th>D</th>
<th>M</th>
<th>A</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>__________________________________________________________________________</td>
<td>__________________________________________________________________________</td>
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</tr>
</tbody>
</table>

### 1. Calculate.

#### Example:

\[(7 + 6) + 2^3\]

\[= 13 + 8\]

\[= 21\]

<table>
<thead>
<tr>
<th>a. ((8 + 5) + 2^2 = )</th>
<th>b. ((2^3) - (3 + 2) = )</th>
<th>c. ((7 + 6) + 7^2 = )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>d. ((4 + 2) - 5^2 = )</th>
<th>e. ((3^2) - (3 + 2) = )</th>
<th>f. ((5 - 1) + 4^3 = )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

### 2. Calculate.

#### Example:

\[(3^3) - (4 - 5)\]

\[= 9 - (-1)\]

\[= 10\]

<table>
<thead>
<tr>
<th>a. ((1^3) + (3 - 5) = )</th>
<th>b. ((6^2) - (6 - 8) = )</th>
<th>c. ((4^2) - (5 - 7) = )</th>
</tr>
</thead>
<tbody>
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</table>

<table>
<thead>
<tr>
<th>d. ((8 - 7) - 4^3 = )</th>
<th>e. ((9 - 10) + 2^3 = )</th>
<th>f. ((5 - 7) + 7^2 = )</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
3. Calculate.

Example: \( \sqrt[3]{8} + (5 + 1) \)
\[ = 2 + 6 = 8 \]

a. \( \sqrt{4} + (2 + 3) \)

b. \( \sqrt{36} + (5 + 6) \)
c. \( (8 + 4) + \sqrt[3]{27} \)

d. \( \frac{\sqrt{64}}{2 + 1} \)
e. \( (6 + 8) + \sqrt{144} \)
f. \( (4 - 3) + \sqrt{16} \)

4. Calculate.

Example: \( \sqrt[3]{125} - (3 - 8) \)
\[ = 5 + 5 = 10 \]

a. \( \sqrt{4} + (5 - 6) \)

b. \( \sqrt{64} - (5 - 6) \)
c. \( (8 - 10) + \sqrt{36} \)

d. \( \sqrt{9} + (2 + 3) \)
e. \( (6 + 8) + \sqrt{144} \)
f. \( (4 - 3) + \sqrt{16} \)

5. Calculate.

a. \( (\sqrt{25}) + (5 + 4) + (6^2) \)

b. \( (9^2) + (\sqrt{36}) - (6 + 2) \)

c. \( (\sqrt{125}) + (3) + (5 - 6) \)

d. \( (5 + 4) - (5^3) - (\sqrt{8}) \)

e. \( (10 - 5) + (\sqrt{81}) - (6^2) \)
f. \( (1^3) - (3 - 4) - (\sqrt{144}) \)

Problem solving

If the answer is one hundred and the calculation has three operations, with a cube root and a square number, what could the calculation be?
26  More calculating with exponents

Write down all the rules and definitions you know about exponents and the calculation of exponents.

1. Calculate.

Example:
\[
\frac{2^3}{2^2} = \frac{2 \times 2 \times 2}{2 \times 2} \quad \text{or} \quad 2^{3-2} = 2^1 = 2
\]

Remember
\[
\frac{x^m}{x^n} = x^{m-n}
\]

a. \(\frac{4^4}{4^1}\)
b. \(\frac{7^4}{7^3}\)
c. \(\frac{11^9}{11^7}\)
d. \(\frac{10^3}{10^2}\)
e. \(\frac{8^4}{8^2}\)
f. \(\frac{9^{10}}{9^4}\)

2. Calculate and simplify your answer if possible.

Example:
\[
\left(\frac{3}{4}\right)^2 = \frac{3^2}{4^2} = \frac{3 \times 3}{4 \times 4} = \frac{9}{16}
\]

You did it like this.
\[
\left(\frac{3}{4}\right)^2 = \frac{3^2}{(2^2)^2} = \frac{3^2}{2^4} = \frac{9}{16}
\]

... and your friend like this.
Talk about it.
3. Calculate.

Example:
\[
\sqrt{\frac{9}{25}} = \sqrt{\frac{3^2}{5^2}} = \frac{3}{5}
\]

You did it like this.

... and your friend like this.

Talk about it.

Problem solving

Write an algebraic expression where the numerator and denominator are written in exponential form.
Numeric patterns

What does each statement tell you. Give two more examples of each.

**Constant difference:**
- e.g. –3; –7; –11; –15
- “Add –4” to the previous term or counting in “–4s”.

**Constant ratio:**
- e.g. –2; –4; –8; –16; –32
- “Multiply the previous term by 2.”

**Not having a constant difference or ratio:**
- e.g. 1; 2; 4; 7; 11; 16
- “Increase the difference between consecutive terms by 1 each time”.

<table>
<thead>
<tr>
<th>1. What is the constant difference between the consecutive terms?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 3, 5, 7, 9</td>
</tr>
<tr>
<td>d. 7, 14, 21, 28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. What is the constant ratio between the consecutive terms?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 3, 9, 27, 81</td>
</tr>
<tr>
<td>d. 8, 16, 32, 64</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Do these patterns have a constant difference or a constant ratio or neither?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 1, 4, 10, 19</td>
</tr>
<tr>
<td>d. 12, 10, 6, 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. What is the constant difference or ratio between the consecutive terms?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 5, –15, 45, –135</td>
</tr>
<tr>
<td>d. 4, –20, 100, –500</td>
</tr>
</tbody>
</table>

Numeric patterns are commonly divided into arithmetic (made by adding or subtracting a number each time) and geometric (which involve multiplying or dividing by a number). Some geometric patterns are exponential, that is, they are made by multiplying by an exponent.
5. Complete the table and then state the rule.

<table>
<thead>
<tr>
<th>Example:</th>
<th>Position</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the term</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>12</td>
<td>15</td>
<td>n \times 3</td>
<td></td>
</tr>
</tbody>
</table>

i. Complete the table.
ii. State the rule.
iii. Determine term value as asked.

a. 

<table>
<thead>
<tr>
<th>Position</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the term</td>
<td>4</td>
<td>8</td>
<td>16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rule? What will the value of the 20th term be?

b. 

<table>
<thead>
<tr>
<th>Position</th>
<th>5</th>
<th>15</th>
<th>25</th>
<th>35</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the term</td>
<td>12</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rule? What will the value of the 45th term be?

c. 

<table>
<thead>
<tr>
<th>Position</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the term</td>
<td></td>
<td></td>
<td>–12</td>
<td>–15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rule? What will the value of the 46th term be?

d. 

<table>
<thead>
<tr>
<th>Position</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the term</td>
<td>4</td>
<td>9</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rule? What will the value of the nth term be?

e. 

<table>
<thead>
<tr>
<th>Position</th>
<th>0</th>
<th>1</th>
<th>3</th>
<th>4</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the term</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rule? What will the value of the nth term be?

**Problem solving**

a. If the constant ratio is –8, what could a sequence of numbers be?
b. Draw diagrams to illustrate the arithmetic patterns in questions 2a and d and the geometric patterns in 5a and d.
Talk about this.

Talk about this.

Position of hexagon in pattern | 1st term | 2nd term | 3rd term | 4th term | 5th term | n
---|---|---|---|---|---|
Number of matches | 1 | 12 | 18 | 24 | 30 | ?

Read the top row.
The positions: 1st term, 2nd term, 3rd term, 4th term, 5th term, nth term
If the 2nd term’s position is 2 and its value is 12 the rule is 2 \times 6 = 12. Does this rule \( n \times 6 \) hold true for the other positions? What is the value of the 1st term?

1. **Draw more matchsticks to make the next pattern in a sequence of hexagons.**

   Hexagon pattern 1:

   What will the next pattern be?
The rule: add one matchstick to each side.

   (1 \times 6)

   Hexagon pattern 2:

2. **Calculate the number of matchsticks used.**

   a. 1st hexagon has 1 matchstick per side \( 1 \times 6 = 6 \)

   b. 2nd hexagon has 2 matchsticks per side

   c. 3rd hexagon has 3 matchsticks per side

   d. 4th hexagon has 4 matchsticks per side

3. **Record your results in this table.**

<table>
<thead>
<tr>
<th>Position of hexagon in pattern</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>10</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of matches</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   10th hexagon =

   \( n \)th hexagon =
4. Complete the following:

Example: 8, 15, 22, 29, ...

<table>
<thead>
<tr>
<th>Term</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>18</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the term</td>
<td>8</td>
<td>15</td>
<td>22</td>
<td>29</td>
<td>127</td>
<td>7(n) + 1</td>
</tr>
</tbody>
</table>

Add 7 to the previous position.
7 \times \text{the position of the term} + 1 ___.
7(n) + 1, where “n” is the position of the term.
7(n) + 1, where “n” is a natural number.

a. 13, 25, 37, 49...

<table>
<thead>
<tr>
<th>Term</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>17</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the term</td>
<td>8</td>
<td>15</td>
<td>22</td>
<td>29</td>
<td>127</td>
<td>7(n) + 1</td>
</tr>
</tbody>
</table>

b. 6, 11 16, 21 ...

<table>
<thead>
<tr>
<th>Term</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>22</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the term</td>
<td>8</td>
<td>15</td>
<td>22</td>
<td>29</td>
<td>127</td>
<td>7(n) + 1</td>
</tr>
</tbody>
</table>

c. 3, 5, 7, 9 ...

<table>
<thead>
<tr>
<th>Term</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>41</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the term</td>
<td>8</td>
<td>15</td>
<td>22</td>
<td>29</td>
<td>127</td>
<td>7(n) + 1</td>
</tr>
</tbody>
</table>

5. Draw and complete your own tables using the following information:

a. \(4(n) + 1\)

<table>
<thead>
<tr>
<th>Term</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the term</td>
<td>8</td>
<td>15</td>
<td>22</td>
<td>29</td>
<td>127</td>
</tr>
</tbody>
</table>

b. \(6(n) + 1\)

<table>
<thead>
<tr>
<th>Term</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the term</td>
<td>8</td>
<td>15</td>
<td>22</td>
<td>29</td>
<td>127</td>
</tr>
</tbody>
</table>

c. \(8(n) + 3\)

<table>
<thead>
<tr>
<th>Term</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of the term</td>
<td>8</td>
<td>15</td>
<td>22</td>
<td>29</td>
<td>127</td>
</tr>
</tbody>
</table>

---

**Problem solving**

a. Draw the first three terms of a triangular number pattern (as you did for a hexagon using matches in question 1). Identify the rule. Complete the table.

<table>
<thead>
<tr>
<th>Position of ___ in pattern</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>10</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of matches</td>
<td>8</td>
<td>15</td>
<td>22</td>
<td>29</td>
<td>127</td>
<td>7(n) + 1</td>
<td></td>
</tr>
</tbody>
</table>

b. Then do similar tables, but only for the first three terms, for these patterns.
   i. Square number pattern
   ii. Pentagonal number pattern
   iii. Octagonal number pattern
In Grade 7 you learned about input and output values. Make a drawing to illustrate input and output values.

**Input and Output Values**

Input | Process | Output
---|---|---

1. Complete the following:

**Example:**

$$t = p \times 2 + 3$$

<table>
<thead>
<tr>
<th>$p$</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>19</td>
</tr>
</tbody>
</table>

- **Example:**
  
  $$t = p \times 4 - 2$$

<table>
<thead>
<tr>
<th>$p$</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>16</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

- **Example:**
  
  $$t = p \times 2 + 7$$

<table>
<thead>
<tr>
<th>$p$</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>28</td>
<td>36</td>
</tr>
</tbody>
</table>

- **Example:**
  
  $$g = p \times 2 + 10$$

<table>
<thead>
<tr>
<th>$p$</th>
<th>$g$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>15</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

- **Example:**
  
  $$t = p \times 4 - 8$$

<table>
<thead>
<tr>
<th>$p$</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>46</td>
</tr>
<tr>
<td>32</td>
<td>60</td>
</tr>
<tr>
<td>46</td>
<td>74</td>
</tr>
<tr>
<td>60</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td></td>
</tr>
</tbody>
</table>

This is the rule for this flow diagram.
2. What is the rule?

Example:

<table>
<thead>
<tr>
<th>$p$</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>31</td>
</tr>
<tr>
<td>12</td>
<td>47</td>
</tr>
<tr>
<td>20</td>
<td>79</td>
</tr>
<tr>
<td>36</td>
<td>143</td>
</tr>
<tr>
<td>68</td>
<td>271</td>
</tr>
</tbody>
</table>

If $s = r \times 5 - 9$, where $r = -2$, what is $s$?

$y = -x + (-3)$ is the rule. Show this in a table with $x$ to $-3, -2, -1, 0, 1, 2$.

3. Describe the relationship between the numbers in the top row and those in the bottom row of the table. Then write down the values for $m$ and $n$.

Example:

<table>
<thead>
<tr>
<th>$x$</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>$m$</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>30</td>
<td>27</td>
<td>$n$</td>
<td>21</td>
<td>18</td>
<td>15</td>
</tr>
</tbody>
</table>

$m = 1$  
$n = 24$  
Rule is $y = -3x + 24$

Problem solving

If $s = r \times 5 - 9$, where $r = -2$, what is $s$?

If $y = -x + (-3)$ is the rule. Show this in a table with $x$ to $-3, -2, -1, 0, 1, 2$.
**Algebraic vocabulary**

Match the words with the algebraic equation.

An algebraic expression looks like this: $4a^2 + 5 = 12$

We read: four times $a$ to the power of 2, plus 5.

1. Circle the variable.
   a. $x + 7 = 10$
   b. $2x + 5 = 9$
   c. $8 + x = 10$

2. Circle the constant.
   a. $x + 8 = 14$
   b. $3x + 10 = 19$
   c. $5 + 9 = 20$

3. Circle the coefficient.
   a. $8x$
   b. $9a$
   c. $4x + 2 = 10$

4. Circle the operator.
   a. $8 \times x$
   b. $9a$
   c. $4x + 2 = 10$

5. Circle the power/exponent.
   a. $5^2$
   b. $3^2 + 2^2 = 31$
   c. $4^2 + 1^3 = 17$

6. Circle the equations with “like terms”.
   a. $6a + 7a =$
   b. $2a + 3b =$
   c. $7b + 19 =$

7. Circle the equations with “unlike terms”.
   a. $6a + 3a =$
   b. $7x + 2y =$
   c. $7x + 2x =$

8. Circle the algebraic expression.
   a. $2a + 7$
   b. $7a$
   c. $3a + 22$

**Like and unlike terms:**
We can add “3 apples” and “4 apples”, but we cannot add “3 apples” and “4 pears”.
9. Circle the algebraic equations.
   a. $3a + 2 = 10$
   b. $10b$
   c. $7b + 2 = 16$

10. Revision: Write an algebraic expression for each of the following descriptions:

   a. Six more than a certain number.
   b. Six less than a certain number.
   c. A certain number less than six.
   d. A number repeated as a term three times.
   e. A certain number times itself.

continued ☛
11. Explain the following algebraic terms in your own words:

a. What does $3^n$ mean in 3, 9, 27, 81...$3^n$?

b. What does $2^n + 1$ mean in 3, 5, 9, ...$2^n + 1$?

b. What does $3^n - 7$ mean in –4, 2, 20, ...$3^n - 7$?
d. For which values of \( n \) will the sequence: 16, 22, 28, 34, 40, ..., have the rule \( 6(n + 1) + 4 \)?

e. What does \( n \) represent in the following sequence: 8, 10, 14, 22, ..., with the rule \( 6 + 2^n \)?

f. What is the role of \( 7(n) + 2 \) in the sequence 9, 16, 23, 30, ... \( 7(n) + 2 \)?

**Problem solving**

Create an algebraic expression with three like and three unlike terms. What does \( n \) mean in \( 7(n + 2) \) (\( n^{th} \) term)?
Discuss this:
We can add “3 apples” and “4 apples”, but we cannot add “3 apples” and “4 pears”.

Give 5 examples of like terms.

1. Simplify.

<table>
<thead>
<tr>
<th>Example: (3a + 4a)</th>
<th>Underline the variable in red.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(= 7a)</td>
<td>Underline the constant in blue.</td>
</tr>
</tbody>
</table>

a. \(5a + 3a = \) 

b. \(6m - 2m = \)

c. \(7x - 2x = \)

d. \(1n + 5n = \)

e. \(9z + 7z = \)

f. \(3t + 5t = \)

2. Simplify.

<table>
<thead>
<tr>
<th>Example: (3a^2 + 5a^2)</th>
<th>Underline the variable in red.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(= 8a^2)</td>
<td>Underline the constant in blue.</td>
</tr>
</tbody>
</table>

Note: \(3a^2 + 5a^2\) is not \(8a^4\)

<table>
<thead>
<tr>
<th>Example: (3a^2 + 5a^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(= 8a^2)</td>
</tr>
</tbody>
</table>

a. \(1a^2 + 2a^2 = \)

b. \(8r^2 + 5r^2 = \)

c. \(2t^2 + 4t^2 = \)

d. \(4t^2 - 3t^2 = \)

e. \(3m^2 - 2m^2 = \)

f. \(5b^2 - 2b^2 = \)

3. Calculate.

<table>
<thead>
<tr>
<th>Example 1: (5x^2 + 4x^2 = 9x^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 2: (5x + 4x = 5x + 4x)</td>
</tr>
</tbody>
</table>

a. \(4x^2 + 2x^2 = \) 

d. \(8a^3 + 2a = \)

e. \(3b^3 + 3b = \)

b. \(5x^2 + 5x = \)

c. \(8a^2 - 5b^2 = \)

e. \(3b^3 + 3b = \)

f. \(8c^3 - 2c^3 = \)
4. Simplify.

Example: \(3a^2 \times 4a^2\)

\[
= (3a^2)(4a^2) \quad \Rightarrow \quad 3 \times 4 \times a^2 \times a^2 = 12a^4
\]

a. \(2a \times 3a = \quad \)

b. \(2c^2 \times 5c^2 = \quad \)

c. \(5b^2 \times 4b^2 = \quad \)

d. \(7c \times 8c = \quad \)

e. \(6b \times 2b = \quad \)

f. \(5a^2 \times 4a^2 = \quad \)

5. Simplify.

Example: \(3a^2 + 4a^2\)

\[
= \frac{3a^2}{4a^2} = \frac{3}{4} \times \frac{a^2}{a^2} \quad \Rightarrow \quad \frac{3}{4}
\]

a. \(1a \div 7a = \quad \)

b. \(3f \div 5f = \quad \)

c. \(4a^2 \div 2a^2 = \quad \)

d. \(5b^3 \div 2b^3 = \quad \)

e. \(9c \div 9c = \quad \)

f. \(3x \div 6x = \quad \)

**Problem solving**

Create a sum with six like terms. Simplify it.
Like terms: integers

What is an integer? Give some examples.

Revise the following:

• A positive number \times a positive number = a positive number
• A negative number \times a negative number = a positive number
• A negative number \times a positive number = a negative number
• A positive number + a positive number = a positive number
• A negative number + a negative number = a negative number
• A positive number + a negative number = a positive or a negative number

1. Simplify.
   Example: $-3a - 4a = -7a$
   a. $-5a + 3a = \underline{\phantom{\quad}}$
   b. $-6m - 2m = \underline{\phantom{\quad}}$
   c. $-7x - 2x = \underline{\phantom{\quad}}$
   d. $1n - 5n = \underline{\phantom{\quad}}$
   e. $-9z + 7z = \underline{\phantom{\quad}}$
   f. $-3t + 5t = \underline{\phantom{\quad}}$

2. Simplify.
   Example: $-3a^2 - 5a^2 = -8a^2$
   a. $1a^2 - 2a^2 = \underline{\phantom{\quad}}$
   b. $-8r^2 - 5r^2 = \underline{\phantom{\quad}}$
   c. $2x^2 - x^2 = \underline{\phantom{\quad}}$
   d. $-4t^2 - 3t^2 = \underline{\phantom{\quad}}$
   e. $3m^2 - 2m^2 = \underline{\phantom{\quad}}$
   f. $-5b^2 - 2b^2 = \underline{\phantom{\quad}}$

   Example 1: $5x^2 - 4x^2 = x^2$
   Example 2: $5x + 4x^2 = 5x + 4x^2$
   a. $-4x^2 + 2x^2 = \underline{\phantom{\quad}}$
   b. $-5x^2 + 5x = \underline{\phantom{\quad}}$
   c. $-8a^2 - 5b^2 = \underline{\phantom{\quad}}$
   d. $-8a^3 + 2a = \underline{\phantom{\quad}}$
   e. $-3b^3 + 3b = \underline{\phantom{\quad}}$
   f. $-8c^3 - 2c^3 = \underline{\phantom{\quad}}$
4. Simplify.

Example: $3a^2 \times 4a^2 = (3a^2)(4a^2) = 12a^4$

a. $2a \times -3a =

b. $-2c^2 \times -5c^2 =

c. $-5b^2 \times 4b^2 =

d. $-7c \times 8c =

e. $-6b \times 2b =

f. $3a^2 \times -4a^2 =

5. Calculate.

Example: $3a^2 \div 4a^2 = -\frac{3a^2}{4a^2} = -\frac{3}{4}$

a. $-1a \div 7a =

b. $3f \div -5f =

c. $-4a^2 \div 2a^2 =

d. $-5b^3 \div -2b^3 =

e. $-9c \div -9c =

f. $-3x \div 6x =

Problem solving

Share with your family what like terms are.
Write a number sentence, algebraic expression or algebraic equation to help you solve the following problems:

a. If Peter is seven years younger than Jabu and Jabu is two years older than Tshepo, how old are Jabu and Tshepo if Peter is 12 years old?

b. Sandra buys three more apples than Lebo bought. Lebo has seven apples left after he has sold 17 apples. If Sandra only sells eight apples, how many does she have left?

c. Thabo is 10 cm taller than Lebo, and Lebo is 7 cm shorter than Mpho. How tall is Mpho if Thabo is 178 cm tall?
d. Tshepo gets R5 more than Alwin. Alwin get R2 less than Lebo. How much more does Tshepo get than Lebo if Lebo gets R20?


e. James weighs 80 kg and Jenny weighs $x$ kg less. How much do they weigh together?


f. Tea Company A makes 700 more tea-bags than Tea Company B. Tea Company B makes 300 tea-bags less than Tea Company C. How much more must Tea Company A produce to make 5 000 tea-bags per day, if Tea Company C produces 3 600 tea bags per day?


Problem solving

Create your own word problem and get a friend to try it out.
Talk about this:
Sipho has seven marbles and John has five. How many do they have altogether?

What is the keyword in the problem telling you which operation to use?

What does “altogether” tell us?

What are the quantities?
• Sipho’s 7 marbles
• John’s 5 marbles

What is the relationship?
The relationship is Sipho’s marbles + John’s marbles = total marbles

The number sentence is: 7 + 5 = ____

1. Solve the following:

Example:
Sipho has \(7n\) marbles and John has \(5n\). How many do they have altogether?

Keyword: addition
Relationship: Sipho’s marbles + John’s marble = total marbles
Number sentence: \(7n + 5n = 12n\)

a. Mpho, Ryna and Gugu have 15 books altogether. Mpho has two books and Gugu has nine books. How many books does Ryna have?

Keyword: ____________________________
Relationship: ____________________________
Number sentence: ____________________________

b. Belinda is on page 84 of her book. The book has 250 pages. How many pages does she still have to read?

Keyword: ____________________________
Relationship: ____________________________
Number sentence: ____________________________
c. Thomas read 64 pages and Linda read 52. How many more pages did Thomas read?

Keyword: ______________________________________________________________
Relationship: ______________________________________________________________
Number sentence: ______________________________________________________________

d. Thabo buys $x$ amount of toffees. He has eight left from yesterday. If today he eats half of all the toffees he bought, he will have 3 left for tomorrow. How many did he buy?

Keyword: ______________________________________________________________
Relationship: ______________________________________________________________
Number sentence: ______________________________________________________________

2. Write a different number sentences for each statement.

a. Money earned each month – expenses = money available each month
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________

b. Speed × time = distance
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________

c. Distance from A to B + distance from B to C = distance A to C.
_______________________________________________________________________________
_______________________________________________________________________________
_______________________________________________________________________________

Problem solving

Kabelo has a certain number of computer games. He gets four more for his birthday. How many games did he have before his birthday if he now has 37 games?
Additive inverse and reciprocal

The additive inverse of –4 is 4, and the additive inverse of 4 is –4.

Talk about the reciprocal of a number.

What do you notice? To get the reciprocal of a number, just divide 1 by the number.

1. Revision.
   a. What is the inverse operation of addition? ________________________________
   b. What is the inverse operation of subtraction? ______________________________
   c. What is the inverse operation of multiplication? ______________________________
   d. What is the inverse operation of division? ________________________________

2. Complete.

   Example: \(-4 \quad = 0\)
            \[\Rightarrow -4 + 4 = 0\]

   a. \(-5 \quad = 0\)        b. \(-9 \quad = 0\)        c. \(11 \quad = 0\)
   d. \(6 \quad = 0\)        e. \(-10 \quad = 0\)       f. \(-2 \quad = 0\)

3. What is the additive inverse? Show your calculation to check that the sum of a number and its additive inverse equals zero.

   Example: \(-9\)
            \[-9 + 9 = 0\] 9 is the additive inverse, since \(-9 + 9 = 0\)

   a. \(-7\)        b. \(-9\)        c. \(-10\)
   d. \(-20\)      e. \(3\)        f. \(-15\)

Example: \[ 4 \times \_ \_ = 1 \]

\[ 4 \times \frac{1}{4} = 1 \]

a. \[ 5 \times \_ \_ = 1 \]

b. \[ 7 \times \_ \_ = 1 \]

c. \[ \frac{1}{15} \times \_ \_ = 1 \]

d. \[ \_ \_ \times \frac{1}{2} = 1 \]

e. \[ \_ \_ \times \frac{1}{12} = 1 \]

f. \[ 9 \times \_ \_ = 1 \]

5. What is the reciprocal of the following? Show your calculation to check that a number multiplied by its reciprocal equals 1.

Example: The reciprocal of 4 is \(\frac{1}{4}\) since \(4 \times \frac{1}{4} = 1\)

a. \[ 5 \]

b. \[ \frac{1}{8} \]

c. \[ \frac{1}{15} \]

d. \[ 7 \]

e. \[ 3 \]

f. \[ 11 \]

Problem solving

What is the multiplicative and additive inverse of 32?
Balance an equation

How will you balance these?

Now write down five different equations.

1. Solve for \( x \).

   Example: \( x + 5 = -4 \)
   
   \[
   x + 5 - 5 = -4 - 5 \\
   x = -9
   \]

   a. \( x + 3 = 7 \)
   
   b. \( x - 6 = 2 \)

   c. \( x - 10 = 5 \)
   
   d. \( x - 8 = 6 \)

   e. \( x + 5 = 4 \)
   
   f. \( x - 11 = 7 \)

2. Solve for \( x \):

   Example: \( x + 3 + 2 = -8 \)
   
   \[
   x + 5 = -8 \\
   x + 5 - 5 = -8 - 5 \\
   x = -13
   \]

   a. \( x + 2 - 4 = 6 \)
   
   b. \( x + 7 + 2 - 3 = 9 \)

   c. \( x + 5 + -8 = -5 \)
   
   d. \( x - 8 + 3 = 7 \)

   e. \( x + 4 - 2 + 6 = -2 \)
   
   f. \( x + 11 - 7 + 9 = 7 \)
3. Solve for $x$:

Example: $x - 2 + 3 = -5$
- $x + 1 = -5$
- $x + 1 - 1 = -5 - 1$
- $x = -6$

(a) $x + 3 + 2 = 4$
(b) $x + 8 + 7 = -8$
(c) $x + 6 + 6 = 3$
(d) $x - 9 - 8 = -3$
(e) $x - 5 - 4 = 7$
(f) $x - 11 + 5 = -7$

4. Solve for $x$:

Example: $2x = 16$
- $2x = 16$
- $x = 8$

(a) $3x = 27$
(b) $5x + x = 18$
(c) $2x - 4 = 10$
(d) $7x = 28$
(e) $5m = 25$
(f) $15ab = 30$

5. Solve for $x$:

Example: $\frac{2x}{3} = 12$
- $\frac{2x}{3} = 12$
- $\frac{2x}{3} \times 3 = 12 \times 3$
- $\frac{2x}{3} = \frac{36}{3}$
- $x = 18$

(a) $\frac{4x}{5} = 12$
(b) $\frac{x}{4} = 15$
(c) $\frac{x}{2} = 30$
(d) $\frac{x}{3} = 6$
(e) $\frac{x}{3} = 24$
(f) $\frac{x}{7} = 7$

Problem solving

Solve for $a$, if $a$ divided by 25 equals 100.
### Substitution

#### What does it mean to substitute in mathematics?

In algebra, letters such as *x* or *y* are used to represent values which are usually unknown. These letters can be used in equations or expressions to help solve a variety of problems. The value of the variable may be given to you, e.g. if 
\[ a = 2 \text{ and } b = 3, \] 
then 
\[ a + b = 2 + 3 = 5. \]

#### Term 1

1. **If \( x = 2 \), then:**
   - Example: 
     \[ 2x + 5 \]
     \[ = 2(2) + 5 = 4 + 5 = 9 \]
   - a. \( 4x + 8 = \)
   - b. \( 6 + 3x = \)
   - c. \( 5x + 3x = \)
   - d. \( 8x + 3 = \)
   - e. \( 9 + 5x = \)
   - f. \( 7x - 4x = \)

2. **Do the same sums but this time with \( x = -2 \).**
   - a. \( 4x + 8 = \)
   - b. \( 6 + 3x = \)
   - c. \( 5x + 3x = \)
   - d. \( 8x + 3 = \)
   - e. \( 9 + 5x = \)
   - f. \( 7x - 4x = \)

3. **If \( x = 3 \), then:**
   - Example: 
     \[ x^2 + 5 \]
     \[ = (3)^2 + 5 = 9 + 5 = 14 \]
   - a. \( x^2 + 2 = \)
   - b. \( x^2 + 11 = \)
   - c. \( x^2 + 10 = \)
   - d. \( x^2 - 3 = \)
   - e. \( x^3 + 30 = \)
   - f. \( x^2 - 14 = \)

4. **Do the same sums but this time with \( x = -3 \).**
   - a. \( x^2 + 2 = \)
   - b. \( x^2 + 11 = \)
   - c. \( x^2 + 10 = \)
   - d. \( x^2 - 3 = \)
   - e. \( x^3 + 30 = \)
   - f. \( x^2 - 14 = \)

5. **If \( x = 4 \), then:**
   - Example: 
     \[ (x^2) - x \]
     \[ = (4^2) - 4 = 16 - 4 = 12 \]
   - a. \( x^2 + x = \)
   - b. \( -x + x^2 = \)
   - c. \( x^2 + x^2 = \)
   - d. \( x^2 - x = \)
   - e. \( -x^3 - x = \)
   - f. \( x - x^3 = \)
6. Do the same sums but this time \( x = -4 \).

   a. \( x^2 - x = \)
   b. \( -x + x^2 = \)
   c. \( x^2 + x^2 = \)
   
   d. \( x^3 - x = \)
   e. \( -x^3 - x = \)
   f. \( x - x^3 = \)

7. Solve for \( x \):

   Example: \(-5x = 10\)
   \[
   \frac{-5x}{-5} = \frac{10}{-5} \quad \Rightarrow \quad x = -2
   \]

   a. \(-2 = 10\)
   b. \(-6x = -12\)
   c. \(2x = 4\)
   
   d. \(-3x = 9\)
   e. \(7x = 14\)
   f. \(-4x = 16\)

8. Solve for \( x \):

   Example: \(2x - 6x = 16\)
   \[
   -4x = 16 \\
   \frac{-4x}{-4} = \frac{16}{-4} \\
   x = -4
   \]

   a. \(4x - 5x = 8\)
   b. \(8x + 4x = 4\)
   c. \(-2x - 10x = 3\)
   
   d. \(3x + 11x = 7\)
   e. \(9x - 4x = 5\)
   f. \(x - 3x = 2\)

Problem solving

Create a three-term algebraic expression using \( x \) as your variable and then substitute \(-6\) for \( x \).

You must include fractions in your expression.

What is the value of your expression if \( x = 3 \)?
Algebraic equations

You know that an **expression** is a collection of quantities linked by operators (+, –, × and ÷) that together show the value of something.

**What is an equation?**

An equation says that two things are the same, using mathematical symbols.

An equation uses the equal (=) sign.

**Example:**

\[ 6 + 4 = 11 - 1 \]

1. **Solve for \( x \) and test your answer.**

Example:

Solve for \( x \) if \(-2x = 8\)

\[-2x = 8\]

\[\frac{-2x}{-2} = \frac{8}{-2}\]

\[x = -4\]

Test:

\[-2(-4) = 8\]

**Notes:**

- \(-2 ÷ -2 = \frac{-2}{-2} = 1\) (positive one)

<table>
<thead>
<tr>
<th>a. (4x = 16)</th>
<th>b. (5x = 25)</th>
<th>c. (-8x = 64)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test: (-2x = -2)</td>
<td>[-2x = -2]</td>
<td>[-2x = -8]</td>
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<tr>
<td>[x = -4]</td>
<td>[x = -4]</td>
<td>[x = -8]</td>
</tr>
<tr>
<td>[\text{Test: } -2x = 8]</td>
<td>[\text{Test: } 5x = 25]</td>
<td>[\text{Test: } -8x = 64]</td>
</tr>
</tbody>
</table>

2. **Solve for \( x \) and test your answer.**

Example:

Solve for \( x \) if \(3x + 1 = 7\)

To solve the equation requires two steps.

Add \(-1\) to both sides of the equation.

\[3x + 1 - 1 = 7 - 1\]

\[3x = 6\]

Then divide both sides of the equation by 3

\[\frac{3}{3} = \frac{6}{3}\]

\[x = 2\]

Test:

\[3x + 1\]

\[= 3(2) + 1\]

\[= 6 + 1\]

\[= 7\]

<table>
<thead>
<tr>
<th>a. (4x + 1 = 9)</th>
<th>b. (5x + 2 = 12)</th>
<th>c. (2x - 4 = 6)</th>
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</thead>
<tbody>
<tr>
<td>d. (2x - 8 = -10)</td>
<td>e. (-2x - 6 = -14)</td>
<td>f. (3x - 6 = -3)</td>
</tr>
<tr>
<td>[\text{Test: } 3x + 1]</td>
<td>[\text{Test: } 5x + 2]</td>
<td>[\text{Test: } 2x - 4]</td>
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<td>[= 2(2) - 4]</td>
</tr>
<tr>
<td>[= 6 + 1]</td>
<td>[= 12 + 2]</td>
<td>[= 4 - 4]</td>
</tr>
<tr>
<td>[= 7]</td>
<td>[= 14]</td>
<td>[= 0]</td>
</tr>
</tbody>
</table>

**Problem solving**

Write an algebraic equation for twice a number is twenty-four.

Write an algebraic equation for twice a number decreased by twenty-nine is seven.
Write down the key words you use when solving a problem.

1. Revision: Solve for \(x\).
   a. \(x + 5 = 13\)
   b. \(x - 8 = 16\)
   c. \(x - 7 = -9\)
   d. \(-2x = 4\)
   e. \(-3x = -6\)
   f. \(3x + 1 = 13\)

2. Solve the following:
   a. When six is added to four times a number the result is 50. Find the number.

   b. The sum of a number and nine is multiplied by \(-2\) and the answer is \(-8\). Find the number.

   c. The length of a rectangular map is 37.5 cm and the perimeter is 125 cm. Find the width.

   d. Find the area of a rectangle with a length of \(2x\) cm and a breadth of \(2x + 1\) cm. Write your answer in terms of \(x\).

   e. If the area of a rectangle is \((4x^2 - 6x)\) cm\(^2\), and its breadth is \(2x\) cm, what will its length be in terms of \(x\)?

   f. If \(y = x^2 + 1\), calculate \(y\) when \(x = 4\)

   g. Thandi is six years older than Sophie. In three years Thandi will be twice as old as Sophie. How old is Thandi now?

   h. In a given amount of time, Mr Shabalala drove twice as far as Mrs Shabalala. Altogether they drove 180 km. Find the number of kilometres driven by each.
Divide monomials, binomials and trinomials by integers or monomials

1. Simplify. Test your answer.

Example:
\[
\frac{x^4 \cdot x^2}{x^2} = \frac{x^4}{x^2} \cdot \frac{x^2}{x^2} = x^{4-2} \cdot x^{2-2} = x^2
\]

Test through substitution: \(x = 2\)
\[
\frac{2^4 \cdot 2^2}{2^2} = \frac{16 \cdot 4}{4} = 16 \text{ (Correct)}
\]

a. \(\frac{x^3 \cdot x}{x} = \)

b. \(\frac{x^4}{x^2} = \)

c. \(\frac{x^5}{x} = \)

2. Simplify.

Example:
\[
\frac{x^2 + x^2}{x} = \frac{x^2}{x} + \frac{x^2}{x} = x^2 + x^2
\]

Test through substitution: \(x = 2\)
\[
\frac{x^2 + x^2}{2} = \frac{4 + 4}{2} = 4
\]

\(x^2 - 1 = (2)^2 - 1 = 3\)

a. \(\frac{x^6 - x^2}{x^3} = \)

b. \(\frac{x^2 - x^2}{x^2} = \)

c. \(\frac{x^4 - x^2}{x^2} = \)


Example:
\[
\frac{x^6 - 2x^4 - 3}{x^3} = \frac{x^6}{x^3} - \frac{2x^4}{x^3} - \frac{3}{x^3} = x^{6-3} - 2x^{4-3} - \frac{3}{x^3}
\]

Test through substitution: \(x = 2\)
\[
\frac{2^6 - 2 \cdot 2^4 - 3}{2^3} = \frac{64 - 2 \cdot 16 - 3}{8} = \frac{64 - 32 - 3}{8} = \frac{30}{8} = \frac{15}{4}
\]

\(x^2 - 2 = (2)^2 - 2 = 4 - 2 = 2\)

a. \(\frac{x^6 - 2x^4 - 3}{x^3} = \)

b. \(\frac{x^2 - 2x^4 - 3}{x^3} = \)

c. \(\frac{x^4 - 2x^4 - 3}{x^3} = \)

Problem solving

Divide a polynomial (multi-term algebraic expression) by a monomial. Solve it.
Look at the following. What do you notice?

1. Revision: calculate the following making use of the distributive property:

   Example:
   \[2 \times (3 + 4) = 2 \times 3 + 2 \times 4 = 6 + 8 = 14\]
   
   a. \(2 (3 + 6) = \) 
   b. \(4 (8 + 1) = \)
   c. \(6 (9 + 4) = \)
   d. \(8 (2 + 3) = \)
   e. \(3 (5 + 6) = \)
   f. \(10 (7 + 8) = \)

2. Simplify.

   Example:
   \[2 (x + 5) = 2 \times x + 2 \times 5 = 2x + 10\]
   
   a. \(2 (x + 4) = \)
   b. \(4 (x + 7) = \)
   c. \(5 (x + 2) = \)
   d. \(6 (3 + x) = \)
   e. \(3 (6 + x) = \)
   f. \(7 (x - 9) = \)


   Example:
   \[2 (x^2 + x + 3) = 2 \times x^2 + 2 \times x + 2 \times 3 = 2x^2 + 2x + 6\]
   
   a. \(2 (x^2 + x + 4) = \)
   b. \(4 (3 + x + x^2) = \)
   c. \(6 (7 + x + x^2) = \)
   d. \(7 (2 + x + x^2) = \)
   e. \(3 (x^2 + x + 3) = \)
   f. \(3 (5 + x + x^2) = \)

Problem solving

Multiply any number by a trinomial (three-term algebraic expression). Simplify it.
Calculate the square numbers, cube numbers and square roots of single algebraic terms

Revis: laws of exponents.

Example: \(x^m \times x^n = x^{m+n}\)

1. Revision: calculate.

Example: \(x^m \times x^n = x^{m+n}\)

a. \(x^4 \times x^5 = \)  

b. \(a^5 \times a^7 = \)  

c. \(c^6 \times c^4 = \)  

d. \(m^8 \times m^5 = \)  

e. \(y^6 \times y^8 = \)  

f. \(t^4 \times t^5 = \)

2. Revision: calculate.

Example: \(x^2 \times x^3 = x^{2+3} = x^5\)

a. \(x^4 \times x^5 = \)  

b. \(a^2 \times a^3 = \)  

c. \(b^6 \times b^4 = \)  

d. \(c^2 \times c^3 = \)  

e. \(m^4 \times m^5 = \)  

f. \(x^4 \times x^5 = \)

3. Use the example to complete the following:

Examples: \(4x^6 = 2x^3 \times 2x^3\)

a. \(16x^4 = \)  

b. \(18x^9 = \)  

c. \(64x^4 = \)

d. \(15x^4 = \)  

e. \(60x^6 = \)  

f. \(144x^{12}\)

4. Calculate.

Example: \(\sqrt[3]{36x^{10}} = \sqrt[3]{4x^7 \times 9x^3} = 6x^{\frac{10}{3}}\)

a. \(\sqrt{25x^7}\)  

b. \(\sqrt[4]{49x^8}\)  

c. \(\sqrt[3]{100x^6}\)  

d. \(\sqrt[4]{4x^{12}}\)  

e. \(\sqrt[6]{16x^{18}}\)  

f. \(\sqrt[6]{121x^{22}}\)

Problem solving

Write five different equations where the answers are all equal to: \(x = -9\).
Multiple operations: rational numbers

Do this activity with a friend.

\[
\frac{1}{3} a^2 + \frac{1}{4} a^2 = \quad \frac{1}{3} a^2 - \frac{1}{4} a^2 = \\
\frac{1}{3} a^2 \times \frac{1}{4} a^2 = \quad \frac{1}{3} a^2 + \frac{1}{4} a^2 = \\
\]

1. Calculate the following:

Example:
\[
\left( \frac{1}{2} a^2 + \frac{1}{5} a^2 \right) + \left( \frac{1}{2} a^2 \times \frac{1}{4} a^2 \right) = \\
= \frac{5a^2 + 2a^2}{10} + \frac{1}{4} a^4 \\
= \frac{7a^2 + a^4}{10} \\
\]

a. \( \left( \frac{1}{2} a^2 + \frac{1}{8} a^2 \right) + \frac{2}{8} a^2 \times \frac{1}{8} a^2 = \)

b. \( \left( \frac{1}{5} x^2 + \frac{1}{2} y^2 \right) + \left( \frac{1}{5} a^2 + \frac{1}{10} a^2 \right) = \)

c. \( \left( \frac{1}{2} y^2 + \frac{1}{3} y^2 \right) + \left( \frac{1}{2} y^2 \times \frac{1}{3} y^2 \right) = \)

Problem solving

Write a polynomial using rational numbers, like and unlike terms. Simplify.

Example:
\[
\left( \frac{1}{2} a^2 + \frac{1}{4} a^2 \right) + (3a^2 + 4a^2) + (3a^2 - 4a^2) \\
= \left( \frac{2}{4} a^2 \times \frac{1}{4} a^2 \right) + 7a^2 + (-a^2) \\
= \frac{3}{4} a^2 + \frac{6}{4} a^2 \\
= \frac{3}{4} a^2 + \frac{24}{4} a^2 \\
= \frac{27}{4} a^2 \\
= \frac{3}{4} a^2 \\
\]

a. \( (7a^2 + 2a^2) + \left( \frac{1}{2} a^2 + \frac{1}{4} a^2 \right) + (6a^2 - 4a^2) = \)

b. \( \left( \frac{1}{2} y^2 + \frac{1}{5} y^2 \right) + (-9y^2 - 2y^2) - (8y^2 + 4y^2) = \)

Make notes about what you learned.

__________________________________________________________________________________________________________________________________________________________________________________________________________________
More multiple operations

Do this activity with a friend.

What are the like terms?

\[ \frac{1}{5} x^2 + \frac{1}{6} x^2 = \quad \frac{1}{5} x^2 - \frac{1}{6} x^2 = \]
\[ \frac{1}{5} x^2 \times \frac{1}{6} x^2 = \quad \frac{1}{5} x^2 + \frac{1}{6} x^2 = \]

1. Calculate:

Example: \(2(5 + x - x^2) - x(3x + 1)\)

\[= 10 + 2x - 2x^2 - 3x - x\]
\[= -5x^2 + 1x + 10\]
\[= -5x^2 + x + 10\]

This will help you to multiply the constant with all the terms.

a. \(2(x^2 + x + 8) - x(2x + 1) = \)

b. \(5(x^2 + 2) + x(4x + 3) = \)

c. \(3(x^2 + x + 6) - x(5x + 2) = \)

2. Simplify.

Example: \(\left(\frac{1}{3} a^2 \times \frac{1}{4} a^3 \right) + 4(3a^2 + 4a^3) + a(2a + 4)\)

\[= \frac{1}{12} a^5 + 4 \times 7a^2 + 2a^2 + 4a\]
\[= \frac{1}{12} a^5 + 30a^2 + 4a\]

a. \(2(x^2 + x + 8) + x(5x + 2) + (9x^2 - 5x) = \)

b. \(\left(\frac{1}{4} x^2 + \frac{1}{5} x^2 \right) - x(-9x^2 - x^2) - 2(x + 2x + 8) = \)

c. \((3x^2 + 6x^2) + \left(\frac{1}{6} x^2 - \frac{3}{4} x^2 \right) + (2x^2 + 3x^2) = \)

d. \(5(4x + 3x^2 + 6) - (8x^2 - 4x^3) + \left(\frac{1}{4} x^2 \times \frac{1}{5} x^2 \right) = \)

e. \(4(6 + 3x + 2x^2) + \left(\frac{1}{7} x^2 + \frac{1}{5} x^2 \right) - x(-5x + 2x) = \)

Make notes about what you learned.

__________________________________________________________________________________________________________________________________________________________________________________________________________________

Problem solving

Write a polynomial using rational numbers and like and unlike terms. Simplify it.
Division operations

Compare the three blocks.

1. Revision: calculate.

Example: 
\[
\frac{x^4-6x^2-1}{x^2} = \frac{x^4-6x^2-1}{x^2} = x^2 - 6 \cdot \frac{1}{x^2}
\]

a. \( \frac{x^2+3x^2+2}{x^2} \)

b. \( \frac{x^4+2x^2-3}{x^3} \)

c. \( \frac{x^2-4x^2+6}{x^2} \)

2. Calculate.

Example: 
\[
\left( \frac{x^3+6x^2}{x^2} \right) + (3x^2 + 4x^7) + \left( \frac{1}{x^3} + \frac{3}{x^2} \right) + 2(5x - x) + (-x)(3x + 1)
\]
\[
= x^2 + 6 \cdot \frac{1}{x^2} + 7x + 2 \cdot \frac{2}{3}x^4 + 10 - 3x^2 - x
\]
\[
= x^2 + 7x^2 - 3x^2 + 2 \cdot \frac{2}{3}x^4 + 10 + 6 - \frac{1}{x^2} - x
\]
\[
= 5x^2 + \frac{2}{3}x^4 + 16 - \frac{1}{x^2}
\]
\[
= \frac{15}{3}x^2 + \frac{2}{3}x^4 - 16 + \frac{1}{x^2}
\]
\[
= \frac{17}{3}x^2 - x + 16 - \frac{1}{x^2}
\]
\[
= 5\cdot \frac{2}{3}x^2 - x - \frac{1}{x^2} + 16
\]

a. \( 3(7 + x^2) + 2(3x + 1) \left( \frac{1}{x^2} + \frac{1}{4x^2} \right) + (2x^2 - 2x^2) = \)

b. \( \left( \frac{x^3 + 2x^2 + 4}{x^2} \right) + 2(4x^2 + 2x^2) + \left( \frac{x^4 - 6x^2 - 3}{x^2} \right) \left( \frac{1}{3x^4} + \frac{1}{4x^2} \right) = \)

c. \( \left( \frac{x^3 + 4x^2 + 2}{x^2} \right) \left( \frac{1}{3x^2} + \frac{1}{4x^2} \right) - (4x^2 + 2x^2) - \left( \frac{1}{3x^2} + \frac{1}{x^2} \right) \)

Problem solving

Write a polynomial using rational and whole numbers and like and unlike terms. Simplify it.
Constructing geometric figures

Revise the following:

Step 1:
Draw a line. Label a segment AB.

Step 2:
Place the protractor so that the origin (small hole) is over point A. Rotate the protractor so that the base line is exactly along the line AB.

Step 3:
Using (in this case) the inner scale, find the angle desired – here 45°.

Step 4:
Make a mark at this angle, and remove the protractor.

Step 5:
With a ruler, draw a line from A to the mark you have just made. Label this point C.

Step 6:
The line drawn (a ray) makes an angle with a measure of 45° between the two rays AC and AB.

1. Label and measure the following angles. You might need to extend the lines.
   a. Acute angle: ABC
   b. Right angle: DEF
   c. Obtuse angle: ABC
   d. Reflex angle: XYS
2. Draw the following using a protractor. Label your geometric figures.

Example: a 60º angle ABC.

Step 1

Step 2

a. **Right angle**

b. **Acute angle**

c. **Reflex angle**

d. **Scalene triangle**

e. **Right angled triangle**

f. **Isosceles triangle**

**Problem solving**

How would you construct an angle with a protractor that is bigger than 180º?

2. Draw the following using a protractor. Label your geometric figures.

**Example:** a 60º angle ABC.

- **Term 2**

- **Constructing geometric figures**

- **Continued**

- **e. Acute angle:** GHI
- **f. Reflex angle:** KLM
- **g. Obtuse angle:** PQR
- **h. Right angle:** GHI
- **i. Right angle:** HGI
- **j. List all the different kinds of angles. Use the first one to guide you.**
  - An acute angle is smaller than 90º.
  - A straight line

- **Remember:** Angles are parts of a circle. This will help you understand how to design a protractor.
1. Use the example to guide you. Construct a triangle with two given angles. Name the type of triangle.

Example: a triangle of which the angles include 45º and 65º.

Step 1

Step 2

a. 90º and 45º  
b. 65º and 75º  
c. 80º and 45º  
d. Write down step by step what you did.

2. Use the example to guide you. Construct a quadrilateral with the two angles given. Label it.

Example: a quadrilateral of which the angles include a 70º angle and a 80º angle.

Step 1

Step 2

a. 68º and 118º  
b. 135º and 70º  
c. 70º and 110º  
d. Write down step by step what you did.

Problem solving

Using a protractor, construct:
(a) any polygon other than a triangle, and
(b) a quadrilateral.
Parallel and perpendicular lines

47

Look at this structure – it is the Nelson Mandela bridge in Johannesburg. Identify the parallel lines, perpendicular lines and line segments.

1. Who will use a compass in their work? For what?

2. Revision: Match column B with column A.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line segment</td>
<td></td>
</tr>
<tr>
<td>Parallel lines</td>
<td></td>
</tr>
<tr>
<td>Perpendicular lines</td>
<td></td>
</tr>
</tbody>
</table>

3. Draw the following line segments with a ruler.

- 5.23 cm
- 7.55 cm
- 65.5 mm
- 23.5 mm
- 8.95 cm

4. Revision: Construct a perpendicular line to bisect a given line. Use the guidelines to help you.

Step 1: Draw a line and mark points A and B on it. Put the compass point on A and open it so that the pencil touches point B. (So you "measured" the length of AB with the pair of compasses.)

Step 2: Leaving the compass point on A, draw an arc with the compass approximately two thirds of the line length.

Step 3: With the compasses' width the same, move the compass point to B and draw another arc which crosses the first arc at two points. Label these points C and D.

Step 4: Draw a line through points C and D bisecting the line AB at E.

5. Draw lines perpendicular to these using a protractor.

Problem solving
Are these lines parallel or not? Say why or why not.
Construct angles and a triangle

Identify the triangles and estimate the size of the angles.

1. Construct a 45° angle. Use the guidelines to help you.
   - **Step 1** Follow the steps for drawing a perpendicular line.
   - **Step 2** Place the compass point on C and draw an arc with the compass a little more than half way between C and B. Then place the compass point on B and draw a same size arc crossing the first one. Label the crossing point F.
   - **Step 3** Draw a line through F to E. This creates two 45° angles (FEC and FEB).
   - **Step 4** Do not adjust your compass. Now move the compass point to B and draw another arc which crosses the first. Label it C.
   - **Step 5** Since the lengths of AC and BC are both equal to the length of AB, we have three points all the same distance from each other. If we join them up, we therefore have an equilateral triangle, with each angle equal to 60°.

2. Give five real-life examples of where we might find 45° angles.

3. Construct an equilateral triangle. Follow the steps and construct your triangle below.
   - **Step 1** Draw a line AB.
   - **Step 2** Put the compass point on A and open it so that the pencil touches B. (So you have "measured" the length of AB with the pair of compasses.)
   - **Step 3** Leaving the compass point on A, draw an arc with the compass roughly where you think the other vertex (corner) of the triangle is going to be. (The distance from A to this point is going to be the same as the length of AB.)
   - **Step 4** Do not adjust your compass. Now move the compass point to B and draw another arc which crosses the first. Label it C.
   - **Step 5** Since the lengths of AC and BC are both equal to the length of AB, we have three points all the same distance from each other. If we join them up, we therefore have an equilateral triangle, with each angle equal to 60°.
4. Construct a triangle of your own choice that is different from the previous one.

5. Construct a 30° angle. Use the guidelines below. Follow the steps to construct a 60° angle (as in Question 2) and then bisect it (as in question 1).

6. How will you construct a 15° angle? Construct it showing it step by step.

7. Construct a triangle with one 30° angle.

Problem solving

Construct any figure with at least one 30° and one 45° angle.
The sum of the interior angles of any triangle equals 180°

How can you prove that the sum of the interior angles of a triangle is equal to 180° using paper and some glue? Paste your proof here.

1. Measure the interior angles of the triangles and add them together. What do you notice?

a. A = 60°
   B = 60°
   C = 60°
   A + B + C = 60° + 60° + 60° = 180°

2. Find angle x.

a. x° + 45° + 90° = 180°
   x° = 180° - 90° - 45°
   x° = 45°

3. If the one angle is __°, what can the other two be? Give 2 pairs of options.

   a. 41
   b. 63
   c. 90
   d. 72
   e. 100

Problem solving

If one angle of the triangle equals 32°, give five pairs of possible answers for what the other angles could be.
### Constructing Quadrilaterals

**What is a quadrilateral?** You can read the rest of the comic strip at the end of this worksheet.

**Question:**

1. Construct and label a quadrilateral with a 90° angle $ABC$. What type of quadrilateral(s) could this be?

   **Steps:**
   - **Step 1:** Use a ruler to draw a line and label point $A$ on the line. With your pair of compasses set at 6 cm, mark point $B$.
   - **Step 2:** Draw arcs 1 cm on either side of $A$. Do the same at point $B$.
   - **Step 3:** Use the arcs to construct lines that are perpendicular to $AB$, one through $A$ and one through $B$. When drawing the arcs set your compass to 6 cm.
   - **Step 4:** Label the crossing points $D$ and $C$.
   - **Step 5:** Join points $D$ and $C$.
   - **Step 6:** Use your protractor to check that the angles are 90° each.

2. Use a ruler and a pair of compasses to construct a rectangle with a length of six centimetres and a width of four centimetres.

   **Steps:**
   - **Step 1:** Use a ruler to draw a line and label point $A$ on the line. With your pair of compasses set at 6 cm, mark point $B$.
   - **Step 2:** Draw arcs 1 cm on either side of $A$. Do the same at point $B$.
   - **Step 3:** Use the arcs to construct lines that are perpendicular to $AB$, one through $A$ and one through $B$. Set your pair of compasses at 4 cm. Place the compass-point at $A$ and mark off and label $D$ on the perpendicular line. Using the same compass setting, place the compass-point at $B$ and mark off and label point $C$ on the perpendicular line.
   - **Step 4:** Join $DC$.

3. Construct the following using a compass:
   - **a.** A square with sides equal to 4 cm.
   - **b.** A rectangle with sides equal to 3.5 cm and 4.2 cm.

   **Measure the angles of $ABCD$.**

**Problem Solving**

Can you construct a quadrilateral with only one 90° angle? Show it.

**Measure the angles of the quadrilateral $ABCD$.**
Constructing quadrilaterals continued

What do you think a parallelogram is?

A parallelogram has four sides.

I think a parallelogram is a quadrilateral with parallel sides.

WELL DONE!

I think a parallelogram is a quadrilateral with parallel sides.

What about other polygons?

You tell me, what can you remember?

I know a quadrilateral is a polygon.

Why do you say so?

So a parallelogram is a polygon with four sides and a parallelogram has two pairs of opposite sides that are parallel.

Do you know about the rhombus?

A rhombus is a parallelogram, but all four sides have the same length.

So a square is a special kind of parallelogram!

What about a trapezium?

Is a trapezium a parallelogram as well?

No, because the trapezium has one pair of parallel sides and a parallelogram has two pairs of parallel sides!

What is the difference between a rectangle and a square?

The opposite sides are also parallel.

Aha, so rectangles and squares are parallelograms as well.

We have learned about geometric figures up to 10 sides. What about geometric figures with more than ten sides?

You still didn’t tell us why you say a quadrilateral is a polygon.

Let me think … Quadrilaterals are formed by four lines and a polygon is formed by three or more lines. So a quadrilateral is a polygon.

Both have 4 sides, but the sides differ. A square has equal sides, in a rectangle, only opposite sides have to be equal.

What! Tell us!

You still didn’t tell us why you say a quadrilateral is a polygon.

Oh, now I can remember what a polygon is.

A polygon is a closed 2D figure formed by three or more straight lines that do not cross over each other.

A square has equal sides. In a rectangle, only opposite sides have to be equal.

Excellent!

Oh, so the top is parallel to the bottom and the sides are parallel to each other.

Do you know about the rhombus?

A rhombus is a parallelogram, but all four sides have the same length.

So a rhombus is a special kind of parallelogram!
What is a polygon?

A polygon is a closed two-dimensional figure formed by three or more line segments that do not cross over each other.

Constructing polygons

1. Use a ruler and pair of compasses to construct a hexagon.
   
   **Step 1:** Draw a circle. Measure the radius with a pair of compasses.
   
   **Step 2:** Make markings the same distance apart on the circumference, using the compasses.
   
   **Step 3:** Label and join the points.

2. Use a ruler and compasses to construct a pentagon on a separate sheet of paper.
   
   **Step 1:** Draw a circle around A with radius AB. Draw a line to join A to B.
   
   **Step 2:** Draw a circle around B with radius AB. Call their intersection points C and D.
   
   **Step 3:** Draw a circle around D with radius DA. Circle D intersects line CD at E, circle A at F and circle B at G.
   
   **Step 4:** Draw a straight line from F through E to intersect circle B at H and a line from G through E to intersect circle A at I.
   
   **Step 5:** Draw an arc at I with radius IA. Draw an arc at H with radius HB. Arcs I and H intersect at J.
   
   **Step 6:** All the points A, B, I, H and J are vertices A, B, C, D, E, F, G, H, I, J.

Problem solving

Construct a polygon different from the ones in this worksheet.
The formula for calculating the sum of the interior angles of a polygon is:

\[(\text{number of sides} - 2) \times 180^\circ\]

Show that this formula is correct.

1. Complete the table.

<table>
<thead>
<tr>
<th>Polygon</th>
<th>Number of sides</th>
<th>Angle size</th>
<th>Total sum of angles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

2. What is this? What polygon/s can you identify?

   a. 
   b. 

3. What geometric figure do you see?

   a. 
   b. 

4. What do you think this is?

5. Use this flow diagram to prepare for a 5 minute presentation.

   Polygon
   \[\text{Triangles}\]
   \[\text{Quadrilaterals}\]
   \[\text{Shapes with more than 4 sides}\]
   - right-angled triangle
   - scalene triangle
   - isosceles triangle
   - equilateral triangle
   - parallelogram
   - rectangle
   - square
   - rhombus
   - kite
   - trapezium
   - pentagon
   - hexagon
   - heptagon
   - octagon
   - nonagon
   - decagon

6. Divide a kite into four triangles and describe the triangles.

   a. 
   b. 

7. Divide a trapezium into triangles and describe the triangles.

   a. 
   b. 

8. Identify and then name the following polygons. Describe each quadrilateral.

   a. 
   b. 

Problem solving

What polygon patterns will you find on a giraffe? Describe them using sides and angles.

Which quadrilaterals have at least one pair of parallel lines?
### Revision: How do you label a geometric figure showing the sides are equal?

<table>
<thead>
<tr>
<th>Sign:</th>
<th>Date:</th>
</tr>
</thead>
</table>

### How do you label a geometric figure showing parallel sides?

<table>
<thead>
<tr>
<th>Term 2</th>
</tr>
</thead>
</table>

1. Complete the following using Cut-out 1.

<table>
<thead>
<tr>
<th>a. Identify ( \text{IOGF} ) What fraction of the square ( \text{ABCD} ) is this shape?</th>
<th>b. Identify ( \triangle ABO ) and ( \triangle ADO ) and make a square. What fraction of the square ( \text{ABCD} ) is this square?</th>
<th>c. Identify ( \triangle HGO ) and ( \triangle DIF ) and make a square. What fraction of the square ( \text{ABCD} ) is this square?</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>d. What shape can you make from ( \triangle HGO ), ( \triangle DIF ), and ( \triangle ECF )? What fraction of the square ( \text{ABCD} ) is this shape?</th>
<th>e. What shape can you make from ( \triangle HGO ), ( \triangle DIF ), ( \triangle DFB ) and ( \text{HBEG} )? What fraction of square ( \text{ABCD} ) is this shape?</th>
<th>f. What shape can you make from ( \triangle HGO ), ( \triangle DIF ), ( \triangle ABO ), ( \text{HBEG} ) and ( \text{IOGF} )?</th>
</tr>
</thead>
</table>

2. Look at the shapes on the next page.

   a. What are the differences and similarities between the quadrilaterals and other polygons?

3. State whether or not the following shapes are polygons. Give reasons for your answers.

   a.  
   b.  
   c.  
   d.  
   e.  
   f.  

### Problem solving

Name the first ten polygons. Try to give an everyday example of each.
What is similarity?

Similar triangles have the following properties:
- They have the same shape but not the same size.
- Each corresponding pair of angles is equal.
- The ratio of any pair of corresponding sides is the same.

These triangles are similar.

We can tell whether two triangles are similar without testing all the sides and all the angles of the two triangles. There are two rules to check for similar triangles. They are called the AA rule and RAR rule. As long as one of the rules is true, the two triangles are similar.

1. Discuss these rules.

AA rule (Angle Angle)

If two angles of one triangle are equal to two angles of another triangle, then the triangles are similar.

a. Given the following triangles, find the length of a.

\[ \begin{align*}
34^\circ & \quad 29^\circ \\
6 & \quad 9 \\
2 & \quad a \\
34^\circ & \quad 29^\circ 
\end{align*} \]

Solution:

Step 1: The triangles are similar because of the AA rule.
Step 2: The ratios of the lengths are equal.
\[ \frac{6}{2} = \frac{9}{a} \]
Step 3: Make use of cross-multiplication to find the unknown value.
\[ 6a = 18 \]
\[ a = 3 \]

RAR rule (Ratio Angle Ratio)

If the angle of one triangle is the same as the angle of another triangle and the sides containing these angles are in the same ratio, then the triangles are similar.

b. Given the following triangles, find the length of a.

\[ \begin{align*}
34^\circ & \quad 10 \\
4 & \quad 6 \\
2 & \quad a \\
34^\circ & \quad 5 
\end{align*} \]

Solution:

Step 1: The triangles are similar because of the RAR rule.
Step 2: The ratios of the lengths are equal.
Step 3: The length of a is 3.

2. Find the length of a. State the rule you are using.

a. 
\[ \begin{align*}
29^\circ & \quad 40^\circ \\
2 & \quad a \\
34^\circ & \quad 46^\circ 
\end{align*} \]

Solution:

Step 1: The triangles are similar because of the AA rule.
Step 2: The ratios of the lengths are equal.
Step 3: Make use of cross-multiplication to find the unknown value.
\[ \frac{2}{a} = \frac{34^\circ}{46^\circ} \]
\[ 2 \times 46^\circ = a \times 34^\circ \]
\[ 6a = 18 \]
\[ a = 3 \]

b. 
\[ \begin{align*}
18^\circ & \quad 53^\circ \\
12 & \quad 24 \\
18^\circ & \quad 53^\circ 
\end{align*} \]

Solution:

Step 1: The triangles are similar because of the RAR rule.
Step 2: The ratios of the lengths are equal.
Step 3: The length of a is 3.

Problem solving

Describe how you would find a missing angle or side of a triangle that is similar to another.
Congruent triangles are triangles that have the same size and shape. This means that the corresponding sides are equal and the corresponding angles are equal.

- The corresponding sides are: AC and DF, AB and DE and CB and FE.
- The corresponding angles are: \( y \) and \( t \), \( x \) and \( s \), \( z \) and \( u \).

There are four rules to check for congruent triangles. They are called the SSS rule, SAS rule, ASA rule and AAS rule.

**1. Discuss the following and draw:**

**SSS rule (Side Side Side)**
If three sides of one triangle are equal to three sides of another triangle then the triangles are congruent.

a. Draw congruent triangles using the SSS rule. Indicate the length of the sides of the triangles.

**SAS rule (Side Angle Side)**
If two sides and the included angle of one triangle are equal to two sides and the included angle of another triangle, then the triangles are congruent.

b. Draw congruent triangles using the SAS rule. Indicate the length of the sides of the triangles.

**ASA rule (Angle Side Angle)**
If two angles and the included side of one triangle are equal to two angles and the included side of another triangle, then the triangles are congruent.
AAS rule (Angle Angle Side)

If two angles and a non-included side of one triangle are equal to two angles and a non-included side of another triangle, then the triangles are congruent. Note that we can also say SAA.

a. Draw congruent triangles using the ASA rule. Indicate the length of the sides of the triangles.

b. Draw congruent triangles using the AAS rule. Indicate the length of the sides of the triangles.

2. Which of the following conditions would be sufficient for the above triangles to be congruent? Give an explanation for each.

a. $a=e, x=u, c=f$

b. $a=e, y=s, z=t$

c. $x=u, y=t, z=s$

d. $a=f, y=t, z=s$

Problem solving

Where in everyday life will we find congruent triangles?
Similar triangles problems

What is the ratio between the sides of these triangles? You might need a calculator. Make the corresponding sides the same colour.

1. Solve for \( x \).

Example:

\[ \triangle ABC \sim \triangle DEF \]

We know that the ratio of corresponding sides are equal.

\[ \frac{AB}{DE} = \frac{BC}{EF} = \frac{AC}{DF} \]

\[ \frac{x}{100} = \frac{300}{100} \]

We do cross multiplication.

\[ 100x = 20000 \]

\[ x = 200 \]

2. A traffic light has a shadow 450 cm long. Ben is 200 cm tall and his shadow is 100 cm long. What is the height of the traffic light? Your friend gave you his two drawings to help you. He explained it and gave you some incomplete notes. Complete it.

Draw the traffic light and Ben.

Draw the similar triangle next to them.

The shadow is 450 cm

B C D E F

The shadow is 100 cm

A B C D E F

Label the triangles

\( \triangle ABC \sim \triangle DEF \)

So we can say:

\[ \frac{BC}{EF} = \frac{AB}{DE} = \frac{AC}{DF} \]

The symbol \( \sim \) means similar.

We do cross multiplication.

\[ \frac{BC}{EF} = \frac{AB}{DE} = \frac{AC}{DF} \]

Problem solving

Write your own problem using ‘similarity of triangles’ to solve it.
1. **Explore these sets of three angles each.**
   a. What do they have in common? What could each set of angles represent?
   \( (30^\circ, 120^\circ, 30^\circ); (50^\circ, 80^\circ, 50^\circ); (55^\circ, 70^\circ, 55^\circ); (20^\circ, 140^\circ, 20^\circ); (70^\circ, 40^\circ, 70^\circ) \)

   b. Draw, label and name the geometric figures.

2. **Explore these sets of four angles each.**
   a. What do they have in common? What could each set of angles represent?
   \( (90^\circ, 90^\circ, 90^\circ, 90^\circ); (120^\circ, 60^\circ, 120^\circ, 60^\circ); (135^\circ, 62^\circ, 47^\circ, 116^\circ); (71^\circ, 130^\circ, 109^\circ, 50^\circ) \)

   b. Draw, label and name the geometric figures.

3. One of the interior angles of a triangle is 60°. The largest angle in the triangle is twice as large as the smallest. What are the two other angle sizes of this triangle? Make a drawing.

4. Two opposite angles of a quadrilateral are 110° each. What will the other two angles measure?

5. A quadrilateral with two pairs of equal sides and four equal angles is divided into two congruent triangles. What are the possible sizes of the angles of the triangles? Explain and make a drawing.

6. Identify all the triangles and quadrilaterals in this net?

   What other polygons can you identify?

7. Which will make the strongest shape? Explain.

   Where is this strongest shape used often?

---

**Problem solving**

Find a structure in your environment made up with triangles and quadrilaterals. Draw and describe it.
1. Look at this photograph.

- What quadrilateral do the beams form?
- What will the sum of the interior angles be? Calculate it without the use of a protractor.
- Identify the triangles.
- What will the sum of the angles be?
- What do you notice about the length of the sides?

2. The bottom row of the structure in the photograph is made up of squares divided into triangles. The sides of the squares are equal, and the sides of the triangles are equal. Now answer these questions.

- What about the diagonals – are they the same length as each side of the four triangles?
- Are the diagonals the same length as the square sides? Check this.
- Why do we use diagonals and triangles in the structures?

3. Look at the geometric figures on these knitted hats.

- Identify the triangles on these hats.
- Identify the quadrilaterals on these hats.
- Don’t measure the angles with a protractor to answer this question. What are the sizes of the angles? Make drawings to support your answer.

4. Divide:

- An equilateral triangle into 4 equilateral triangles.
- A hexagon into triangles.

Problem solving

Share some of these drawings with your family members. Ask them what shapes they can see in them.
Diagonals

1. Identify the quadrilaterals outlined on a knitted piece of fabric then, in accordance with the definition, identify the diagonals of these quadrilaterals.

2. Look at the previous worksheet again.
   a. Draw all the quadrilaterals and triangles done in the previous worksheet.
   b. Draw as many diagonal lines on them as you can.
   c. What do you notice?

3. Draw a trapezium and draw in two diagonals. (You could cut the trapezium up into the triangles, to help you to find the answer.)

4. Complete the table.

<table>
<thead>
<tr>
<th>Shape</th>
<th>Number of sides</th>
<th>Number of diagonals</th>
<th>Difference between number of diagonals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triangle</td>
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<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Quadrilateral</td>
<td>4</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Pentagon</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hexagon</td>
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<td></td>
</tr>
<tr>
<td>Heptagon</td>
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<td></td>
<td></td>
</tr>
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<td>Octagon</td>
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<td></td>
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<tr>
<td>Nonagon</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Decagon</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Problem solving

Find five patterns in your immediate environment with diagonals.
Quadrilaterals, angles and diagrams

Do the following practical activities in pairs.

1. What do you notice?

   a. What geometric figure is formed after the triangles are folded?

   b. What geometric figure is formed by the sum of the three angles of the triangle?

2. Fold a right-angled triangle as shown in the diagrams.

   a. What is the sum of the sizes of the acute angles of the right-angled triangle?

3. Draw any triangle (like △ABC) on paper and cut it out. Find the middle of AB and of AC, and draw a line joining them up. Label it XY.

4. Fold vertex A down over the line XY so that vertex A just touches BC.

5. Fold vertex B and C over as shown.

6. Fold a right-angled triangle as shown in the diagrams.

   a. What is the sum of the sizes of the acute angles of the right-angled triangle?

7. What kind of triangle is shown in the first practical activity at the top of the previous page?

8. Perform the same experiment using an obtuse triangle cut out of paper. Was your prediction correct?

9. Guess whether the paper-folding experiment will work equally well for an obtuse triangle.

10. Show that the sum of the angles of a quadrilateral is 360°. Use the introduction to guide you.
3. Answer these questions.
   a. An isosceles triangle has two angles that each measure 40º. What is the size of the third angle?
   
   b. Determine the size of the third angle of a triangle if the sizes of the other two angles are 110º and 38º.
   
   c. Determine the size of the fourth angle of a quadrilateral if the other three angles are 80º, 79º and 120º.
   
   d. One of the acute angles of a right-angled triangle measures 39º. Determine the size of the other acute angle.
   
   e. An obtuse angle of an isosceles triangle measures 110º. Determine the size of one of the acute angles.

Problem solving

a. If I draw two diagonal lines on a square, what will the sizes of the angles of each of the triangles be?
   b. If I draw two diagonal lines on a parallelogram, one of the triangles has angle sizes of 27º, 27º and 126º. What are the sizes of the angles of the other triangles? Make a drawing to show your answer.
Parallel and perpendicular lines

**Parallel lines** are always the same distance apart and will never meet. We called it equidistant. Make a drawing.

**Perpendicular lines** are lines at right angles (90º) to each other. Make a drawing.

A **transversal** is a straight line intersecting two or more straight lines.

1. Highlight the parallel lines in these pictures.

2. Identify the parallel and perpendicular lines in these photographs. What is each one a photo of?

3. Draw two parallel lines with a line intersecting them. Number the angles.

4. Answer the questions on the following diagram.

   - a. Name a pair of parallel lines.
   - b. How do we know they are parallel?
   - c. Name a transversal.
   - d. Measure the angles where the transversal crosses other lines.

Problem solving

Find a picture of a building and identify all the perpendicular and parallel lines.
Pairs of angles

When parallel lines are crossed by another line (a transversal) there is a regular pattern in the angles around the crossing point. Why do many of the angles in this diagram look the same?

These angles form pairs of angles which have special names.

1a. Identify the pairs of vertically opposite angles.
(Show it by using coloured pencils or symbols.)

i.   ii.

b. Identify the corresponding angles.

i.   ii.

1c. Identify the alternate angles.

i.   ii.

d. Identify all angles that will be equal to the one marked.

i.   ii.

2. Explain what you see in this diagram using only words, without any calculations. How would you work out each angle, if only angle 1 was given?

Problem solving

Find a picture and identify alternate and corresponding angles.
Problems

Revisethe following:
Without measuring the angles, what could the possible angles be? Work in a pair to come up with a possible answer.

1. Solve the following:
   a. If A, B and C are three angles on a straight line, with A = 55º, B = 75º, what is the size of C? Construct and name it.
   b. If A, B and C are the angles of a triangle, with A = 90º and B = 35º, what size is C? Construct and name it.
   c. If A, B, C and D are the angles of a quadrilateral, with A = 150º, B = 30º and C = 150º, what size is D? Construct and name it.
   d. If A, B and C are three angles on a straight line, with A = 24º, B = 49º, what is the size of C? Construct and name it.
   e. If A, B and C are the angles of a triangle, with A = 40º and B = 64º, what size is C? Construct and name it.
   f. If A, B, C and D are the angles of a quadrilateral, with A = 99º, B = 48º and C = 72º, what size is D? Construct and name it.

Problem solving
In which job will a person need to calculate angles. Give an example of such a person and why the person is calculating angles.
Warm up! How fast can you solve the following?

1. Identify the names of six quadrilaterals, three types of angles and three types of triangles.

2. Complete the crossword puzzle.

Across
2. A geometric figure with six sides.
4. An angle that is ninety degrees.
7. Lines that are always the same distance apart and will never meet.
10. Lines that are at right angles (90º) to each other.
11. A triangle with two sides equal.

Down
1. A polygon with the least sides.
3. An angle bigger than ninety degrees.
5. A straight line inside a shape that goes from one vertex to another but not the side.
6. An angle smaller than ninety degrees.
8. Geometric figure with four sides.
9. Line that intersects (crosses over) parallel lines.

Identify parallel lines on the Sudoku puzzle.

How do you play Sudoku?

How do you play Sudoku?

Find some puzzles in a newspaper and solve them with a family member.