

A formula is a set of instructions for working something out.

It is a rule written using letters or words.

The plural of formula is formulae.

People use formulae in everyday life to work out all sorts of things.

An employer may use a formula to work out how much to pay the people who work for them. For example, they could use the formula $P = R \times H$, where P is the pay, R is the amount paid per hour and H is the number of hours worked.

Doctors may use a formula to assess a person's health. For example, they could use a formula to find the person's body mass index (BMI).

This formula is: $BMI = \frac{\text{mass}}{\text{height}^2}$, where the person's mass is measured in kilograms and their height is measured in metres.

If a person's BMI is too high or too low, the doctor may ask them to lose or put on weight, to make them healthier.

> 2.1 Constructing expressions

In this section you will ...

- use letters to represent numbers
- use the correct order of operations in algebraic expressions
- use words or letters to represent a situation.

Key words

coefficient
constant
equivalent
expression
linear expression
term
unknown
variable

You can write an algebraic **expression** by using a letter to represent an **unknown** number.

In the expression $3n + 8$ there are two terms. $3n$ is one **term**. The other term is 8.

The letter n is called the **variable**, because it can have different values.

The **coefficient** of n is 3, because it is the number that multiplies the variable.

The number 8 is called a **constant**.

Example:

Let n represent a mystery number.

You write the number that is 5 more than the mystery number as $n + 5$ or $5 + n$.

You write the number that is three times the mystery number as $3 \times n$ or simply $3n$.

You write the mystery number multiplied by itself as $n \times n$ or simply n^2 .
 $n + 5$ and $3n$ are called **linear expressions** because the variable is only multiplied by a number.
 n^2 is **not** a linear expression because the variable is multiplied by itself.

Tip

$n + 5$ is the same
as $1 \times n + 5$.

Worked example 2.1

Tyler thinks of a number, x . Write an expression for the number Tyler gets when he

- a doubles the number and subtracts 3
- b divides the number by 3 and adds 2
- c adds 2 to the number, then multiplies by 4.

Answer

a $2x - 3$

Multiply x by 2, then subtract 3. Write $2 \times x$ as $2x$.

b $\frac{x}{3} + 2$

Divide x by 3, then add 2. Write $x \div 3$ as $\frac{x}{3}$.

c $4(x + 2)$

Add 2 to x , then multiply the answer by 4. Write $x + 2$ in brackets to show this must be done before multiplying by 4.

Exercise 2.1

- 1 Copy and complete these sentences. Use the words from the cloud.
 In the $4x + 9$, x is a
 $4x$ and 9 are of the expression.
 4 is the of x . 9 is a
 The expression is not equal to anything so cannot be
- 2 a Tanesha has a box that contains x DVDs.
 Choose the correct expression from the cloud that shows the total number of DVDs she has in the box when
 - i she takes 2 out
 - ii she puts in 2 more
 - iii she takes out half of the DVDs
 - iv she doubles the number of DVDs in the box.
- b Tanesha starts with 12 DVDs in the box. Work out how many she will have for Question 2a, parts i to iv.

solved
coefficient
terms
variable
constant
expression

$\frac{x}{2}$ $x + 2$
 $x - 2$ $2x$

2 Expressions, formulae and equations

- 3 a Jake thinks of a number, n .
Write an expression for the number Jake gets when he:
- i multiplies the number by 6, then adds 1
 - ii divides the number by 4, then adds 5
 - iii multiplies the number by 2, then subtracts 3
 - iv divides the number by 10, then subtracts 7.
- b Jake thinks of the number 20. Work out the numbers he gets in Question 3a, parts i to iv.

Tip

Remember the order of operations:

Brackets,
Indices,

Division,
Multiplication,
Addition,
Subtraction

- 4 Match each description with the correct expression.
The first one has been done for you: a and iv.

- | | | | |
|--|--|--------------|-----------|
| a Multiply n by 5 and subtract 4 | b Add 4 and n , then multiply by 5 | | |
| c Multiply n by 5 and add 4 | d Add 5 and n , then multiply by 4 | | |
| e Subtract 4 from n , then multiply by 5 | f Subtract 5 from n , then multiply by 4 | | |
| i $5(n+4)$ | ii $4(n+5)$ | iii $4(n-5)$ | iv $5n-4$ |
| v $5n+4$ | vi $5(4-n)$ | vii $5(n-4)$ | |

Write a description for the expression that has not been matched.

Think like a mathematician

- 5 In pairs or in a small group, discuss.
Sofia and Zara discuss what to write for this problem.
'I think of a number, n . I halve the number then add 4.'



I think the expression is $\frac{n}{2} + 4$



I think the expression is $\frac{n+4}{2}$

What do you think?

Make a conjecture and convince the other members of your group.

- 6 Kia thinks of a number, x .
Write an expression for the number Kia gets when she:
- a divides the number by 3, then adds 1
 - b adds 1 to the number, then divides by 3
 - c subtracts 1 from the number, then divides by 3
 - d divides the number by 3, then subtracts 1.

Think like a mathematician

- 7 In pairs or in a small group, discuss.
Sofia, Zara and Arun discuss what to write for this problem.
'I think of a number, n . I divide by 3, then multiply by 2.'



What do you think?
Make a conjecture and convince the other members of your group.

- 8 a Sort these cards into groups of **equivalent** expressions.

A $\frac{3 \times x}{4}$	B $\frac{x+3}{4}$	C $\frac{4}{3}x$	D $\frac{4 \times x}{3}$	E $\frac{3}{4} \times x$
F $\frac{3}{4}x$	G $\frac{3}{4} + x$	H $\frac{3x}{4}$	I $\frac{4x}{3}$	J $\frac{3+x}{4}$

- b Which card is in a group on its own?

- 9 This is part of Pedro's classwork.

Are Pedro's answers correct? If not, write the correct answers for him.

Question

Write an expression for these.

a one-third of x add 4

b 5 subtract two-fifths of y

Answers

a $\frac{x}{3} + 4$ b $\frac{2y}{5} - 5$

10 a Write an expression for each description.

- i one-half of x add 8
- ii three-quarters of x subtract 12
- iii 7 add four-fifths of x
- iv 20 subtract five-ninths of x

b Describe each expression in words.

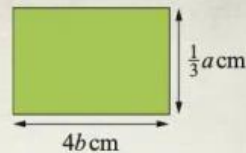
- i $\frac{x}{6} + 2$
- ii $\frac{5x}{7} - 4$
- iii $8 - \frac{2x}{3}$
- iv $3 + \frac{7x}{8}$

11 This is part of Maya's homework.

Question

Write an expression for

- a the perimeter of this rectangle
- b the area of this rectangle.

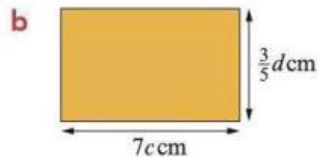
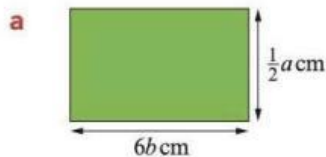


Answers

a perimeter = $\frac{1}{3}a + \frac{1}{3}a + 4b + 4b = \frac{2}{3}a + 8b$ cm

b area = $\frac{1}{3}a \times 4b = \frac{4}{3}ab$ cm²

Use Maya's method to write an expression for the perimeter and area of each of these rectangles. Simplify each expression.



Activity 2.1

Work with a partner.

Take it in turns to say 'Write an expression for ...' and give a description like those in Question 10a.

For example, 'Write an expression for two-thirds of x add 9.'

Your partner must write the expression correctly.

Check their expression. If it is correct, they score 1 point.

Write five expressions each, then check the scores!

- 12** The shortest side of a triangle is y cm.
 The second side is 3 cm longer than the shortest side.
 The third side is twice as long as the second side.
 Write an expression, in its simplest form, for the perimeter of the triangle.

Tip

Start by writing expressions for the second and third sides.

- 13** The price of one bag of cement is $\$c$.
 The price of one bag of gravel is $\$g$.
 The price of one bag of sand is $\$s$.
 Write an expression for the total cost of
- a** one bag of cement and three bags of sand
 - b** three bags of cement, four bags of gravel and six bags of sand.

- 14** The price of one kilogram of apples is $\$a$.
 The price of one kilogram of bananas is $\$b$.
 The price of one kilogram of carrots is $\$c$.
 Write an expression for the total cost of
- a** one kilogram of apples and half a kilogram of bananas
 - b** two kilograms of bananas and three-quarters of a kilogram of carrots
 - c** three kilograms of apples, a quarter of a kilogram of bananas and four-fifths of a kilogram of carrots.

- 15** Brad thinks of a number, y .
 Choose the correct expression from the cloud for when Brad
- a** adds 5 to one-half of y , then multiplies by 6
 - b** adds 6 to one-fifth of y , then multiplies by 2
 - c** adds 2 to five-sixths of y , then multiplies by 6
 - d** adds 5 to two-fifths of y , then multiplies by 6.

$$6\left(\frac{5y}{6} + 2\right) \quad 6\left(\frac{y}{2} + 5\right)$$

$$6\left(\frac{2y}{5} + 5\right) \quad 2\left(\frac{y}{5} + 6\right)$$