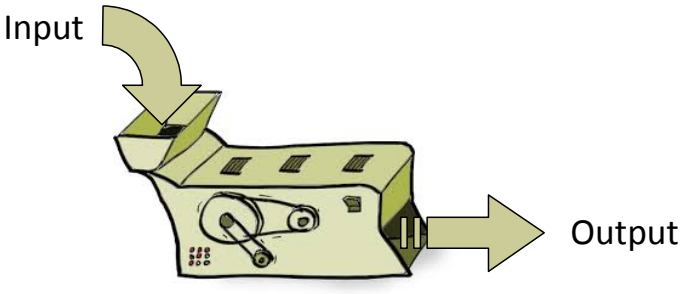
What's my function?





Miss F

If you input a number into this function machine, it outputs a different number.
Look at the table of results.

Input	3	6	15	21
Output	7	10	19	25

Can you describe in words what this function machine actually does?

1 Could you write your number sentence using the shorthand notation we looked at earlier in Algeba_1a?



Amber

In words, the function machine adds 4 to the input and outputs the result.

So if n stands for any number, we could write our rule as

$n \rightarrow n + 4$



Jon

Fitness check

In each of these cases, write down what the function machine does in words and then write the rule using Jon's shorthand idea.



(1)

Input	8	12	23	49
Output	3	7	18	44

(2)

Input	2	6	11	15
Output	12	36	66	90

(3)

Input	9	21	60	84
Output	3	7	20	28

(4)

Input	0.9	1.5	2.1	2.4
Output	3.6	6.0	8.4	9.6



Evie

Evie's solutions

1. This function machine takes away 5 from the input.
   So it could be written in shorthand as $n \rightarrow n - 5$.
2. This function machine multiplies the input by 6.
   So it could be written in shorthand as $n \rightarrow 6 \times n$
3. This function machine divides the input by 3.
   So it could be written in shorthand as $n \rightarrow n \div 3$
4. This function machine multiplies the input by 4.
   So it could be written in shorthand as $n \rightarrow 4 \times n$

Tidying things up

We generally write 4 x n as simply $4n$, and so $4n$ means four times the number.

$4n$ can also mean $n + n + n + n$.

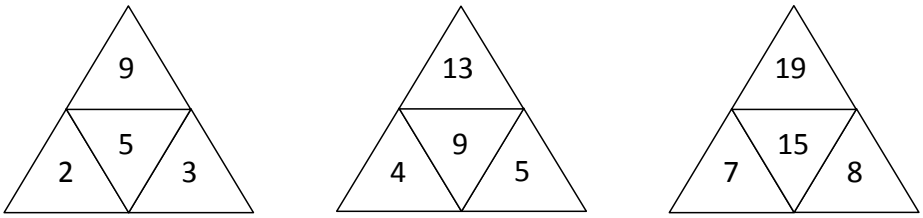
Division is a little bit more complicated but we can write $n \div 4$ as $\frac{n}{4}$.

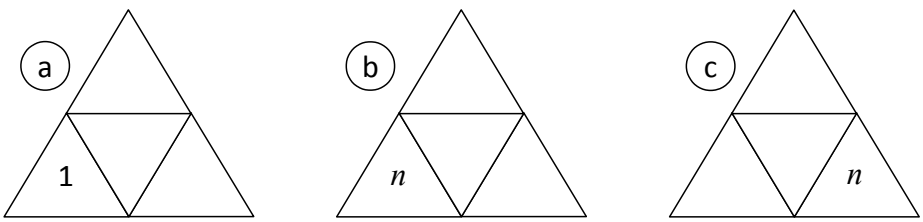
But sometimes it is written as $n/4$ or even $\frac{1}{4}n$.

Fitness check

Write each expression as simply as possible.

1. $5n + 2 \times n - 3n$
2. $10k - 4k + 2 \times k$
3. $2r + r + r + 5r$
4. $2n + 3 + 5n - 1$
5. $(n \div 2) + (n \div 2)$
6. Look at these 6 number triangles. They all follow the same rules.
   Can you work out what is missing?

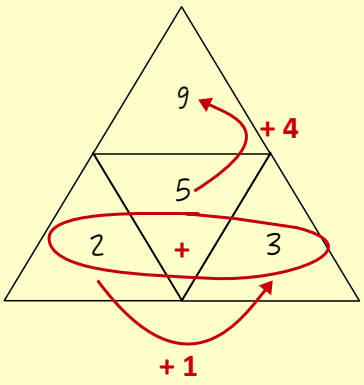






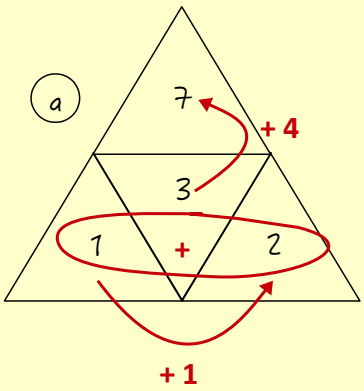
Jon

Jon's solutions to Q6

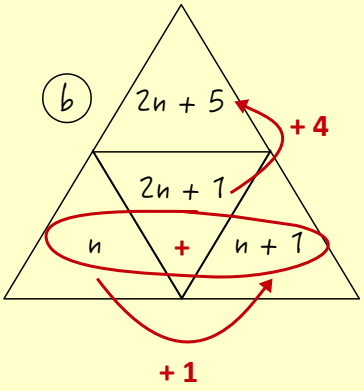


This works for each one

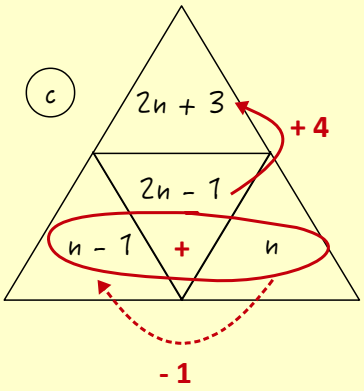
a



b



c



I had to go backwards first
- 1 is the inverse of + 1

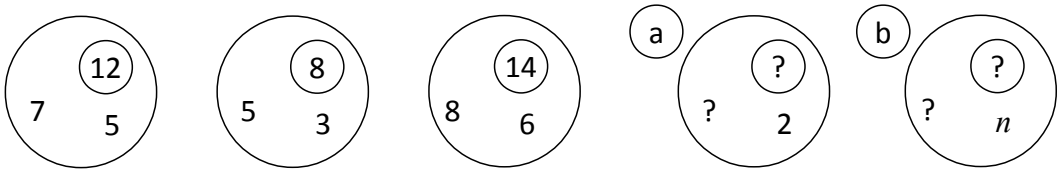
2

Can you explain Jon's solutions to your partner?

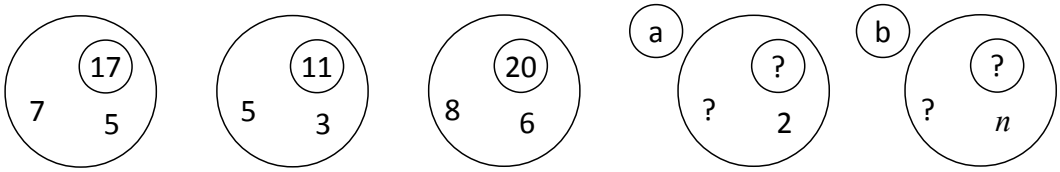
Fitness check

Find what is missing in each of these number puzzles.

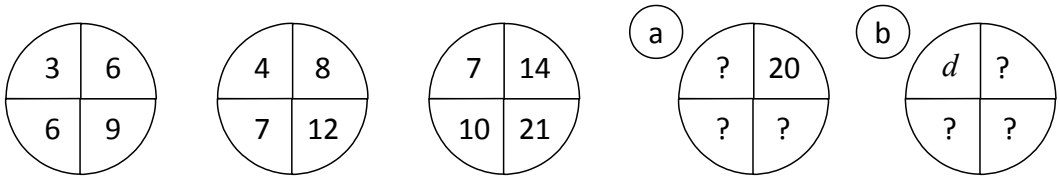
1.



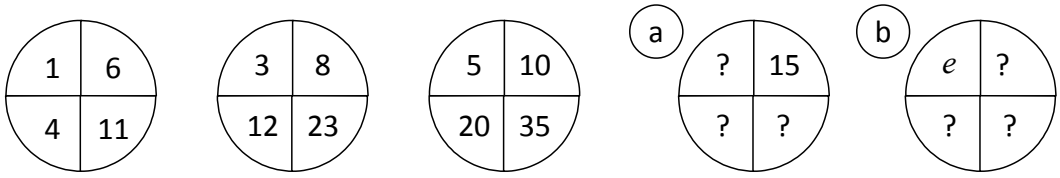
2.



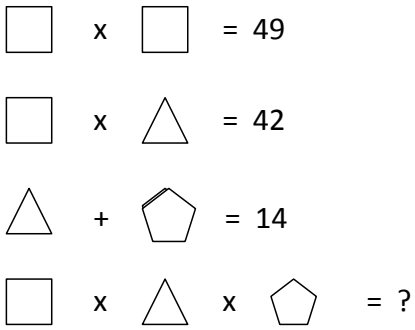
3.



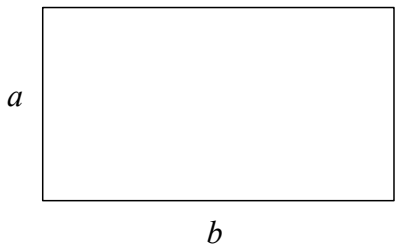
4.



5. The shapes in this question represent 3 different positive numbers:



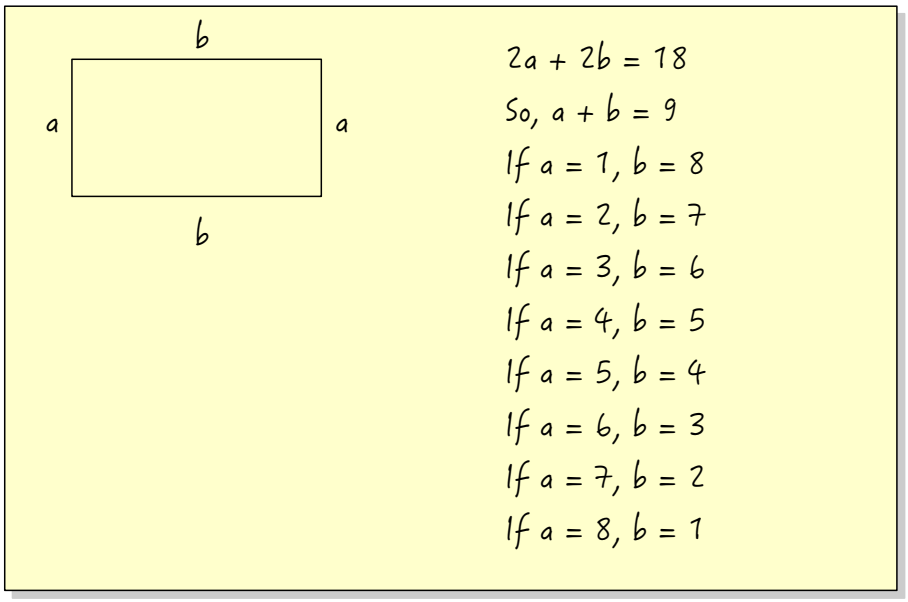
6. The perimeter of this rectangle is 18 cm. If the lengths of each side are whole numbers, what numbers might a and b represent?





Matthew

Matthew's solution to Q6



Let's start thinking algebraically





Mr T

We have already seen that we can use letters to generalise results. For example, suppose we have lots of chairs with 4 legs and one 3-legged stool. How many legs might there be altogether?



Sarah

We could have 23.



Alice

We could have 35.



Jon

We could have 83.



Amber

We could have 103.



Evie

We could have 263.



Taro

But we can't have 281.

3

How does Taro know there can't be 281 legs?



Krish

Krish's explanation

Because each chair has 4 legs, the number of chair legs must be in the 4 times table.

Because the stool has only 3 legs, the total number of legs will always be 3 more than a number in the 4 times table.

So Sarah is right as $5 \times 4 + 3 = 23$

Alice is right as $8 \times 4 + 3 = 35$

Jon is right as $20 \times 4 + 3 = 83$

Amber is right because $25 \times 4 + 3 = 103$

Evie is right because $65 \times 4 + 3 = 263$

And Taro is right because $69 \times 4 + 3 = 279$ and

$70 \times 4 + 3 = 283$, so there cannot be 281 legs.



Mr T

Can you think of a way of writing this algebraically?



Matthew

We can write the four times table as $4n$, so we could write the total number of legs, T, as $4n + 3$. Or simply $T = 4n + 3$, where n is the number of chairs.

4

Can you explain Matthew's thinking?

Fitness check

1. Using Matthew's formula for the number of legs, how many legs would there be if there were:

   a) 30 chairs b) 50 chairs c) 200 chairs

2. Would it be possible to have:

   a) 51 legs? b) 101 legs? c) 1003 legs?

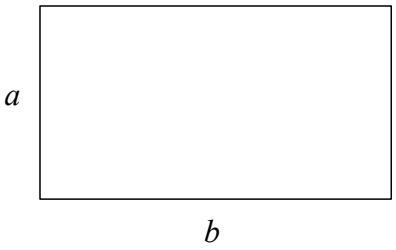
Let's think about writing formulas ...



Miss F

A **formula** is a rule that generally contains numbers and letters. The letters used in a formula are called **variables** as they represent quantities that can change.

For example, look at this rectangle.



The formula for the perimeter could be written as

$P = a + b + a + b$.

But it could also be written as

$P = 2a + 2b$ or $P = 2(a + b)$

In this case the variables are P, a and b.

Suppose, instead, you wanted a formula for the area of the rectangle, you could write $A = a$ x b, but we usually use more shorthand here and replace a x b with ab.
So our formula would be $A = ab$

Fitness check

1. What is the perimeter of a rectangle if
   a) a = 7cm and b = 5cm?
   b) a = 3m and b = 8m?
   c) a = 12.5cm and b = 6m?
2. Calculate the area in each case?

Understanding "like terms".



Miss F

Often, when we are using algebra to make things more concise, and you will hear the expression, "**like terms"**. It will really be helpful later if you can master this idea now. It is easier to understand if I give you examples to think about.

Like terms	Why are these like terms?	Unlike terms	Why are these unlike terms?
-2, 3, 0, 0.5, $\frac{2}{3}$	All are number terms	4, n	First is a number term, second is an n term
$2a$, $-5a$, $\frac{a}{4}$	All are a terms	3, $3a$	First is a number term, second is an a term
ab, ba, $3ab$, $-2ab$	All are terms with a and b	$3a$, $3b$	First is an a term, second is a b term
abc, acb, $3cab$	All are terms with a, b and c	$4abc$, $5ab$	First is a term with a, b and c, the second has only a and b



Any questions so far?

Miss F



Why is ab the same as ba?

Amber

Why are abc and $3cab$ like terms?



Jon

5

How would you answer these questions?



ab means a x b which is the same as b x a, and so is the same as ba.

Sarah

abc means $1abc$ and $3cab$ is the same $3abc$.



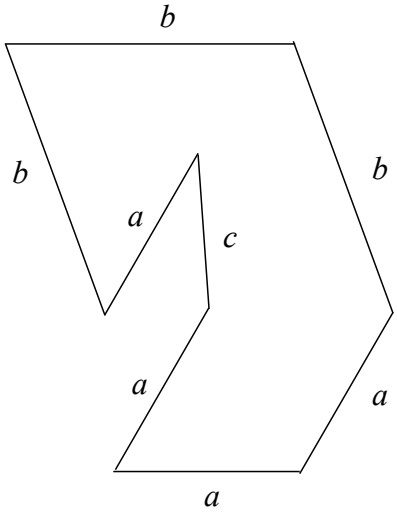
Matthew

Collecting up like terms



Look at this shape. It is made up of 8 rods of varying lengths.

Miss F



6

Can you write down a formula for the perimeter of this shape?



Alice

$P = a + a + b + b + b + a + c + a$



Evie

$P = 4a + 3b + c$

$P = 3a + 3b + a + c$



Krish

7

Do you agree with these answers? If so, which one would you say is the neatest?



Miss F

As you can see, we can only add up or subtract like terms. This process is called **collecting up like terms**. In this way, we end up with the simplest expression or formula.

Fitness test

1. Simplify these expressions by collecting like terms where possible.

a) $3x + 4 + 2x - 1$

b) $2f - 3f + 4$

c) $-3g - 2g$

d) $3 - 2m + 3n$

e) $7c - 4d + 2c - d$

f) $3x + 4y + 3 + x - y$

g) $2f - 3g - 3f + 4g - 2$

h) $6a + 3a + 2 + 5b - 4a + b - 4$

i) $4cd - 2dc + 3c - 2d$

j) $3rs + 2s + 3 - 3r - sr + 2$

2. A cookbook says that the time required to cook a joint of beef is calculated using this formula: 40 minutes per kilo plus 20 minutes. How long will it take to cook a joint of beef that weighs:

   a) 2 kilo b) 2.5 kilo c) 4 kilo?

3. A window cleaner works out the cost of cleaning the windows of a house using the formula,

$$C = 2 + 3w$$

where C is the cost in pounds and w is the number of windows to be cleaned.

How much would he charge for cleaning a house with

a) 3 windows b) 6 windows c) 10 windows?

4. A decorator works out the cost of tiling a wall using the formula,

$$C = 10 + 20ab$$

where C is the cost in pounds, a is the width of the wall in and b is height of the wall both measured in metres.

   a) How much would he charge for a wall that measures 3m by 4m?

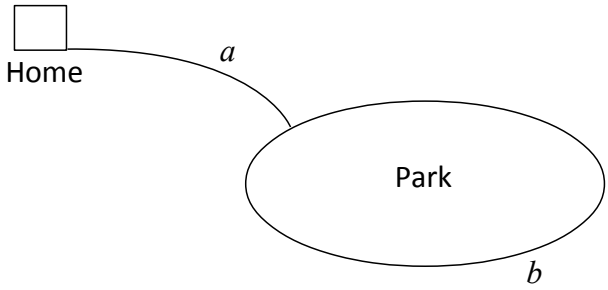
   b) How much would he charge for a wall that measures 3.5m x 2.5m?

Creating a formula



Mr T

Sometimes it is helpful to summarise situations or stories concisely using algebra. For example, suppose I jog to the park each day and then run around the field three times before jogging back home. How could I create a formula to show how far I have jogged?
This diagram might help.

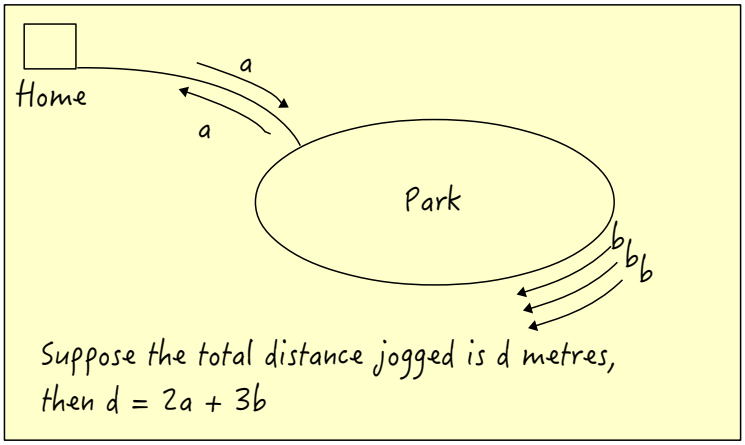


8 Can you create a formula to show how far Mr T jogs each day?



Evie

Evie's solution



Fitness check

1. Using Evie's formula, how far does Mr T jog if:
   a) a = 250m and b = 425m?
   b) a = 375m and b = 550m?
   c) a = 400m and b = 750m?

2. What would the formula be if Mr T jogged:
   a) 2 laps of the park
   b) 5 laps of the park?
   c) 9 laps of the park?

3. A box contains x pieces of Lego. If Matthew uses y pieces to build a model, create a formula to show how many pieces of Lego are left in the box.

4. A box of chocolates contains x chocolates. If Aimee has 4 boxes of chocolates but gives 3 chocolates to Jon, create a formula to show how many chocolates she has left.

5. A bag of sweets contains x sweets. If Taro has y bags of sweets, create a formula to show how many sweets he has altogether.

6. A multi storey car park has 5 different levels, and each level has the same number of car parking spaces (s). At a particular time of day there a many cars parked in the car park (c). Create a formula for the number of spaces still available.

7. Suppose instead, there were l levels in the car park. How will this change your formula?

8. Look carefully at these 4 cards. If $n = 8$, which card has a value closest to 6?

$2n - 9$	$n - 3$	$0.5n$	$0.25n$

9. What is the value of this card

$3n - 2$

if a) $n = 4$ b) $n = 0$ c) $n = -2$

10. Which of these cards have the same value if $x = 6$?

$3x - 16$	$2x - 9$	$0.5x$	$45 - 7x$

11. Look at this rectangle



Not drawn to scale

a) Write down a formula for the perimeter of the rectangle, beginning $P = ...$

b) Write down a formula for the area of the rectangle, beginning $A = ...$

c) If $x = 6$cm and $y = 5$cm, calculate P and A.

d) If $x = 10$km and $y = 8$km, calculate P and A.

12. Look again at Q11. If the perimeter is actually 30km, what might be the values of x and y? Can you find more than one possibility?

Algebra 1b: Mastery questions

1. Simplify this expression by collecting like terms

$$c + c + c$$

A	B	C	D
$3c$	$3 \times c$	$c3$	c^3

2. Simplify this expression by collecting like terms

$$5e + 7e - 4e$$

A	B	C	D
$11e - 4e$	$16e$	$8e$	8

3. Simplify $5 \times 3a \times 4b$

A	B	C	D
$60ab$	$15a + 4b$	$15a + 20b$	$8ab$

4. In the expression $4ab + 5a + 3ba + 7b + 9$, the coefficient of b is

A	B	C	D
12	10	3	7

5. Simplify the following by collecting like terms

$$5a - 4b + 2a + 4b - 8a$$

A	B	C	D
$0a + b$	$0a - b$	$0 - b$	$-b$

6. Simplify the following by collecting like terms

$$8xy - 4y + 3y - 5yx + 4x$$

A	B	C	D
$8xy$	$3xy + 4x - y$	$3xy + 4x + y$	$8xy - 5yx - y + 4x$

7. If $n = 4$, what is the value of $5n - 3$?

A	B	C	D
6	17	20	23

8. If $b = 4$ and $c = 2$, what is the value of $2b + 4c + 3bc$?

A	B	C	D
32	36	40	84

9. The formula for speed is: Speed = $\frac{\text{distance}}{\text{time}}$

   A snail travels 3m in 12 hours. What is the speed of the snail?

A	B	C	D
4 m/hr	3 m/hr	36 m/hr	0.25 m/hr

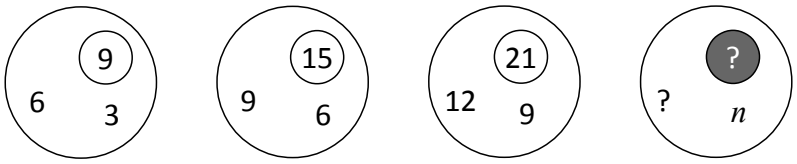
10. When taking my dog for a walk, we first walk to the park and then walk three times around the field. We then walk back home. If the distance to the park is x metres and the distance around the field is y metres, how far do we walk?

A	B	C	D
$x + y$	$x + 3y$	$2x + 3y$	$6xy$

11. A deck chair company has 500 deck chairs at a local beach. At lunchtime on a particular day, d are damaged, and can't be used and h are already on hire. How many deck chairs are still available for hire?

A	B	C	D
500 - d	500 - h	500 – d + h	500 – h – d

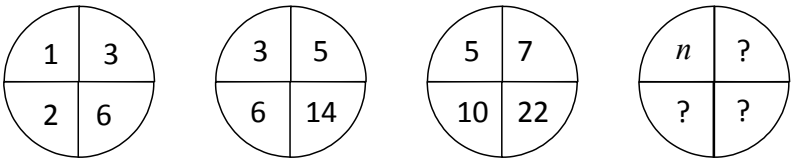
12. Look at this number puzzle. What goes in the shaded circle in the 4th diagram?



A	B	C	D
$n + 3$	$2n + 3$	$n + 6$	$3n$

In Q13 – 15, you will need to show all of your working.

13. Look at this number puzzle. What expressions go in the 4th diagram?



14. If p = 6, which of these cards has a value closest to 0?

$3p - 17$	$p - 5$	$0.5p$	$12.5 - 2p$

15. A formula you will meet later in Science is $v = u + at$.

Calculate the value of v if:

a) $u = 0$, $a = 10$ and $t = 3$

b) $u = 5$, $a = 8$ and $t = 1$

c) $u = -5$, $a = 10$ and $t = 5$