Algebra 4

contents

There are two lessons in this unit, **Algebra 4**.

objectives

The objectives covered in this unit are:

- Add several small numbers.
- Use letter symbols to represent unknown numbers or variables.
- Substitute positive integers into simple linear expressions and formulae.
- Use simple formulae.
- Solve simple linear equations with integer coefficients (unknown on one side only) using an appropriate method.
- Solve problems and investigate in number and algebra.

Using the lesson plans in this unit

These lesson plans supplement the *Springboard 7* materials for Key Stage 3 pupils working toward level 4 in mathematics. All the lessons are examples only. There is no requirement to use them. If you decide to use the lessons, you will need to prepare overhead projector transparencies (OHTs) and occasional resource sheets for pupils to use.

The lessons consolidate work at level 3 and extend into level 4. They are suitable for a group of pupils or a whole class. Whatever the size of the group, the pupils are referred to as 'the class'.

Each lesson will support about 30 to 40 minutes of direct teaching. To help match the time to your timetable, each plan refers to 'other tasks' for pupils, based on *Springboard 7* resources. Select from these, textbook exercises or your own materials to provide practice and consolidation in the main part of a lesson and to set homework. Aim to choose tasks that vary in their level of demand, to suit pupils' knowledge, confidence and rate of progress.

Although the 'other tasks' are listed for convenience at the end of the main part of the lesson, they can be offered at any point, especially between the 'episodes' that form the main activity.

The lesson starters are of two kinds: practice starters and teaching starters. The former are opportunities to rehearse skills that will be needed later in the lesson. Teaching starters introduce an idea that is then developed in the main activity.

You will need to tell pupils what they will learn in the lesson, either in the starter or at the beginning of the main activity. Use the plenary to check pupils' learning against the lesson's objectives and to draw attention to the key points that pupils should remember.

A4.1 Rules and formulae

objectives

- Add several small numbers.
- Use letter symbols to represent unknown numbers or variables.
- Substitute positive integers into simple linear expressions and formulae.
- Use simple formulae.

starter

Vocabulary
add
subtract
sum
difference

Resources
dice (three per group)

Ask a few questions such as:

Q Subtract 8 from 12.
Q What is the difference between 16 and 9?
Q Add 6 to 8.

If necessary, remind pupils how they can bridge through 10.

Demonstrate how knowing that 8 + 6 = 14 leads to:

18 + 6 = 24
28 + 6 = 34
38 + 6 = 44, and so on.

Ask pupils to work in small groups. Give three dice to each group. They will also need pencil and paper to keep their scores. Tell pupils the rules of the game. In turn, each player rolls all three dice. Only fours, fives and sixes count. If you throw only ones, twos or threes, you miss that turn. The player finds the sum of the eligible numbers and adds this to their total score. The first player to reach a target number such as 50 or 100 wins the game.

Encourage pupils to add the numbers mentally. After the game, ask the whole class a few more questions, such as:

Q Why is it impossible to score 11? (the minimum score is 12)

Q How could you score 16? (4, 6, 6 or 5, 5, 6)

Q What scores are possible after one throw? (any number from 12 to 18)

main activity

Vocabulary
rule
formula
substitute

Resources
OHTs A4.1a, A4.1b, A4.1c
computer with data projector
spreadsheet

Show **OHT A4.1a**. Explain that several families are going on a picnic together. The OHT shows some of the rules or formulae that they use when they are preparing for the picnic. Ask the class:

Q How many bottles of water are needed for a picnic for 30 people? (30)

Q 20 bottles of water were packed for the picnic. How many people were going? (20)

Q How many pizzas are needed for 12 people going on a picnic? (3) **For 20 people?** (5)

Q How many paper plates are needed for 9 people? (13) **For 30 people?** (34)

Q How many cheese rolls are needed for 7 people? (19)

Q 35 cheese rolls were prepared for the picnic. How many people were expected to go? (15)

Continue asking similar questions based on the information on the OHT. Encourage pupils to suggest and apply one or two more rules for the picnic, for example, for the number of drinking straws and the number of cans of cola.

Explain that some rules can be written in a shorthand way. Demonstrate by writing on the board:

Take two forks for every person.

number of forks = number of people x 2

Ask:

Q How many forks are needed for 7 people? (14)

Q If 18 forks were taken to the picnic, how many people went along? (9)

Show **OHT A4.1b**. Ask:

Q How many bananas are needed for 30 people going on a picnic? (26)

Q All 16 bananas were eaten at a picnic. How many people went? (20)

Q How many rugs are needed for 12 people on a picnic? (3)

Q 5 rugs were taken to a picnic. How many people went? (20)

Q How many biscuits are needed for 8 people for a picnic? (48)

Q 60 biscuits were packed for a picnic. How many people went? (10)

Q 12 hard-boiled eggs were packed for a picnic. How many people went? (14)

Explain that rules can be written in an even shorter way. Write a rule on the board:

number of apples = number of people + 4

Say that we can make this even shorter. We can write *p* to stand for the *number of people* and *a* to stand for the *number of apples*. So the formula for working out the number of apples becomes:

$a = p + 4$

Give another example.

number of spoons = number of people × 2

We can write *p* to stand for the *number of people* and *s* to stand for the *number of spoons*. So the formula for working out the number of spoons becomes:

$s = p \times 2$ or even shorter $s = 2p$

Show **OHT A4.1c**, and work through the questions.

Write on the board a formula such as $n = m + 10$. Tell pupils that the value of m is 5, and show them how to work out the value of $m + 10$.

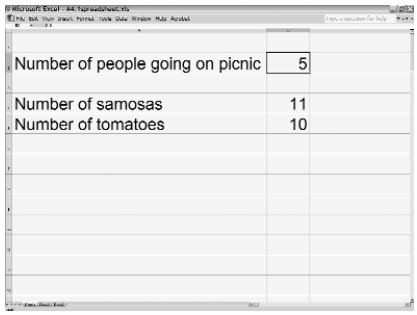
Q What is the value of *n* if *m* equals 50? What if *m* equals 0?

Repeat with a formula such as $a = 2b + 1$.

Tell pupils that the value of b is 8, and show them how to work out the value of $2b + 1$. Remind them that $2b = 2 \times b$.

Q What is the value of *a* if *b* equals 10? What if *b* equals 0?

Using a computer with a data projector, show a simple prepared spreadsheet with hidden formulae in cells B4 and B5, such as the one below. Set the size of the font to 28 pt or larger so that the whole class can see the text.



Ask pupils to suggest the number of people going on the picnic, and enter this into cell B2. Tell them to watch what happens to the numbers in cells B4 and B5. Each time that you enter a new number for the number of people, ask pupils:

Q What do you think the formula is for the number of samosas? Why do you think so?

Q And the formula for the numbers of tomatoes?

other tasks

Springboard 7
Unit 10

There are no relevant exercises on using formulae and substitution in the *Springboard 7* folder. Choose suitable tasks or activities from textbooks or other resources, or devise your own. For practice in adding several small numbers use:

Unit 10 section 1: Mental calculations

1	Adding numbers in your head	page 327
2	Adding multiples of 10 or 100	page 327

plenary

Resources
OHTs A4.1d, A4.1e, A4.1f

Show **OHTs A4.1d, A4.1e and A4.1f** and work through the questions with the class. Explain how pupils should 'show their working'.

Remember

- Algebra uses letters and numbers to replace words and numbers.
- A rule written out in algebra is called a formula.
- 5*y* means 5 times *y*. The number is always written first, so we never write *y*5.
- Numbers can be substituted in a formula to work out the value of something that you want to know.

A4.2 Solving simple equations

objectives

- Use letter symbols to represent unknown numbers or variables.
- Solve simple linear equations with integer coefficients (unknown on one side only) using an appropriate method.
- Solve problems and investigate in number and algebra.

starter

Vocabulary
problem

Resources
OHT A4.2a

Show **OHT A4.2a**, a set of menu problems. Explain to the class that they are to work out the cost of the menu options with no price shown.

Q **How can we work out the cost of milk?** (find the difference between the costs of pasta, salad and milk and pasta and salad)

Q **How can we find the cost of a salad?** (subtract the cost of pasta from the cost of pasta and salad)

Ask pupils to work in pairs to find the costs of the last two options on the first menu.

Q **How shall we start to solve the second problem?**

Discuss pupils' suggestions, then ask them to work in pairs to solve the problem. Invite one or two pairs to explain their solutions to the rest of the class.

Repeat with the third problem.

main activity

Vocabulary
equation
solution
value
inverse
substitute
trial and improvement

Resources
mini-whiteboards
computer with data projector and spreadsheet

Write on the board 8 and 3 + 5. Tell the class that the two numbers that you have written are the same.

Now write 4 + ☐ and 9. Explain that this time a number is missing, and that there is a box symbol in its place. To make the pair of numbers 4 + ☐ and 9 the same, you need to put 5 in place of the box, like this: 4 + 5 and 9.

Write a few more examples on the board, one by one. For example:

6 + ☐ and 11	15 and 10 + ☐	4 × ☐ and 12
10 and ☐ ÷ 2	☐ – 3 and 1	11 – ☐ and 9

Ask pupils to use their whiteboards. Ask:

Q **What number should replace the box to make this pair of numbers the same?**

Say that a letter is often used instead of a box. To show that a pair of numbers is the same, the equals sign is used. So to show that 4 + ☐ and 9 are the same, we write:

$4 + n = 9$

Say that this is called an *equation*. In this equation, putting 5 instead of n makes the equation true. So the *solution* to the equation is $n = 5$. Check by substituting 5 back into the original equation.

Write a few examples of simple equations on the board, one by one. For example:

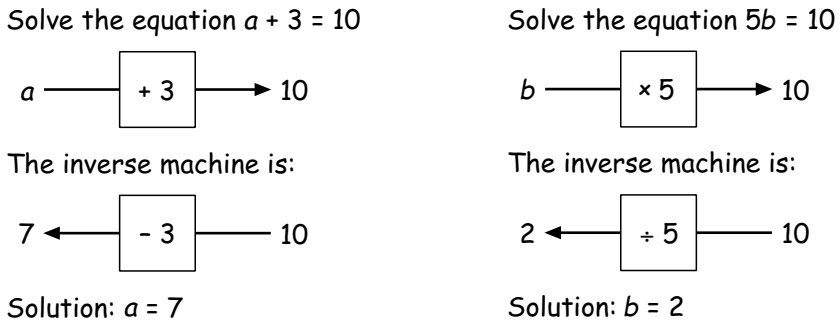
$n + 7 = 12$ $a - 3 = 20$ $100 - x = 80$

Ask pupils to use their whiteboards and to write the solution to each equation in the form $n = 5$.

Remind the class that, when a letter is used for a number, the multiplication sign is often left out, so that $2b$ means the same as $2 \times b$. Ask pupils to use their whiteboards to write the solutions to these equations:

$3p = 12$ $2a = 8$ $4x = 4$

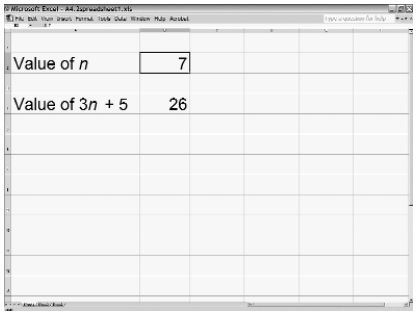
Say that equations can be solved using function machines. Write on the board:



Give pupils a few examples of equations to solve using inverse function machines.

Tell the class that another way to solve equations is by trial and improvement. Using a computer with a data projector, show a simple prepared spreadsheet, such as the one below. Set the size of the font to 28 pt or larger so that the whole class can see the text.

For example, to solve the equation $3n + 5 = 17$, enter the formula 3*B2 + 5 in cell B4. Ask pupils to suggest values for n, and enter these into cell B2. Tell the class to observe what happens in cell B4, and whether the result is too big or too small. Use the feedback to refine suggestions and home in on the correct solution $n = 4$.



other tasks

Springboard 7
Units 6 and 15

Unit 6 section 6: Division
Star challenge 6: Can you crack the code? page 238

Unit 15 section 5: Brackets
2 Brackets and letters page 488

There are no exercises on constructing simple equations in the *Springboard 7* folder. Choose suitable tasks or activities from textbooks or other resource materials, or devise your own.

plenary

Resources
OHT A4.2b

Tell the class that equations with missing numbers can be solved by making sure that each side remains balanced. Show **OHT A4.2b** and discuss the first problem:

$400 + 300 = 600 + \square$

Q What must we do to 400 to make 600? (add 200)

Explain that the left-hand side of the equation, 400 + 300, can be written as:

$(400 + 200) + (300 - 200) = 600 + 100$

Establish that 200 has been added in one place and then subtracted in another place. The overall value of the left-hand side of the equation remains unchanged. By comparing the result with the right-hand side of the original equation we can see that the number that the box represents is 100.

Work through the second problem: $14 + 6 = 4 + \square$.

Q What must we do to 14 to make 4? (subtract 10)

Show that the left-hand side of the equation can be written as:

$(14 - 10) + (6 + 10) = 4 + 16$

In this case, the box represents the number 16.

Ask pupils to work in pairs to solve the remaining equations. After a few minutes, draw the class together and give the answers. Choose two or three of the equations and select a pair of pupils to explain their solutions to the class.

Remember

- Algebra uses letters and numbers to replace words and numbers.
- 5*a* means 5 times *a*.
- Each side of an equation is the same.
- The inverse returns you to where you started.
- One way to solve an equation is to use an inverse function machine.
- Another way to solve an equation is by trial and improvement.

OHT A4.1a

Take one bottle of water for every person.

You need two cheese rolls each, plus five spare.

Take one pizza for every four people.

You need one apple pie for every six people.

Take one bag of crisps each, and ten bags extra.

You need one paper plate each, and four extra.

OHT A4.1b

number of forks = number of people × 2

number of bananas = number of people − 4

number of rugs = number of people ÷ 4

number of biscuits = number of people × 6

number of hard-boiled eggs = number of people − 2

OHT A4.1c

This is the rule for the number of samosas for a picnic.

$s = p - 2$

p stands for the number of people.
s stands for the number of samosas.

There are 20 people.
How many samosas will they take?

How many samosas are needed for 3 people?

If $p = 7$, what is s?

If $p = 50$, what is the value of s?

This is the rule for the number of tomatoes for a picnic.

$t = 2p + 3$

p stands for the number of people.
t stands for the number of tomatoes.

How many tomatoes are needed for 7 people?

There are 8 people.
How many tomatoes will they take?

If $p = 7$, what is the value of t?

If $p = 50$, what is t?

OHT A4.1d

This is how long, in minutes, it takes to cook a chicken.

Microwave oven
Time = (12 × weight in pounds) + 15

Electric oven
Time = (30 × weight in pounds) + 35

How long will it take to cook a 3 pound chicken in a microwave oven? ..... minutes

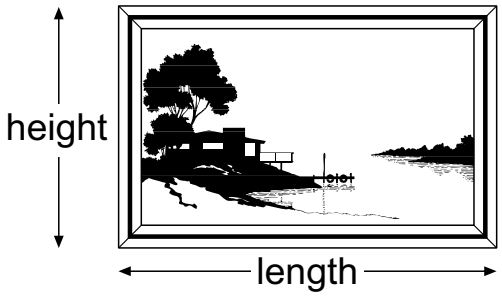
How long will it take to cook a 5 pound chicken in an electric oven? ..... minutes

How much quicker will a 2 pound chicken cook in a microwave oven than in an electric oven?

Show your working.

..... minutes

OHT A4.1e



Here is a picture frame.

For each frame,
the length (L) is twice the height (H), subtract 4.

Write this in symbols. L = ...

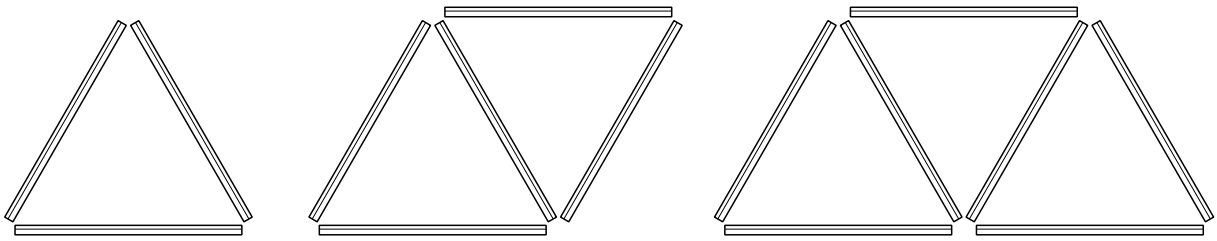
What is the length of a frame
with a height of 36 cm?

Show your working.

..... cm

OHT A4.1f

These patterns are made with matchsticks.



1 triangle
3 matchsticks

2 triangle
5 matchsticks

3 triangle
7 matchsticks

The rule for the number of matchsticks in a pattern is:
2 times the number of triangles, add 1

Jason wants to make the pattern with 9 triangles.

How many matchsticks will he need? ..... matchsticks

M = number of matchsticks
T = number of triangles

Use symbols to write down the rule connecting *M* and *T.*

M = ...

OHT A4.2a

Menu 1

Pasta 55p
Pasta and salad 75p
Pasta, salad and milk 90p
Pasta and milk ....
Salad and milk ....

Menu 2

Egg 30p
Egg and toast 60p
Egg, tomato and toast 70p
Egg, tomato, beans and toast 90p
Tomato, beans and toast ....
Beans and toast ....

Menu 3

Curry £2
Curry and rice..... £2.50
Curry and bhaji £2.40
Curry and kebab £2.80
Curry, rice and bhaji ....
Curry, rice, bhaji and kebab ....
Kebab and rice ....

OHT A4.2b

Write a number in the box at the end of each equation to make it correct.

1 $400 + 300 = 600 + \square$

2 $14 + 6 = 4 + \square$

3 $23 + 2 = 13 + \square$

4 $37 - 20 = 27 - \square$

5 $40 + 17 = 30 + \square$

6 $40 - 17 = 30 - \square$

7 $6 \times 5 = 3 \times \square$

8 $40 \times 10 = 4 \times \square$

9 $7000 \div 100 = 700 \div \square$