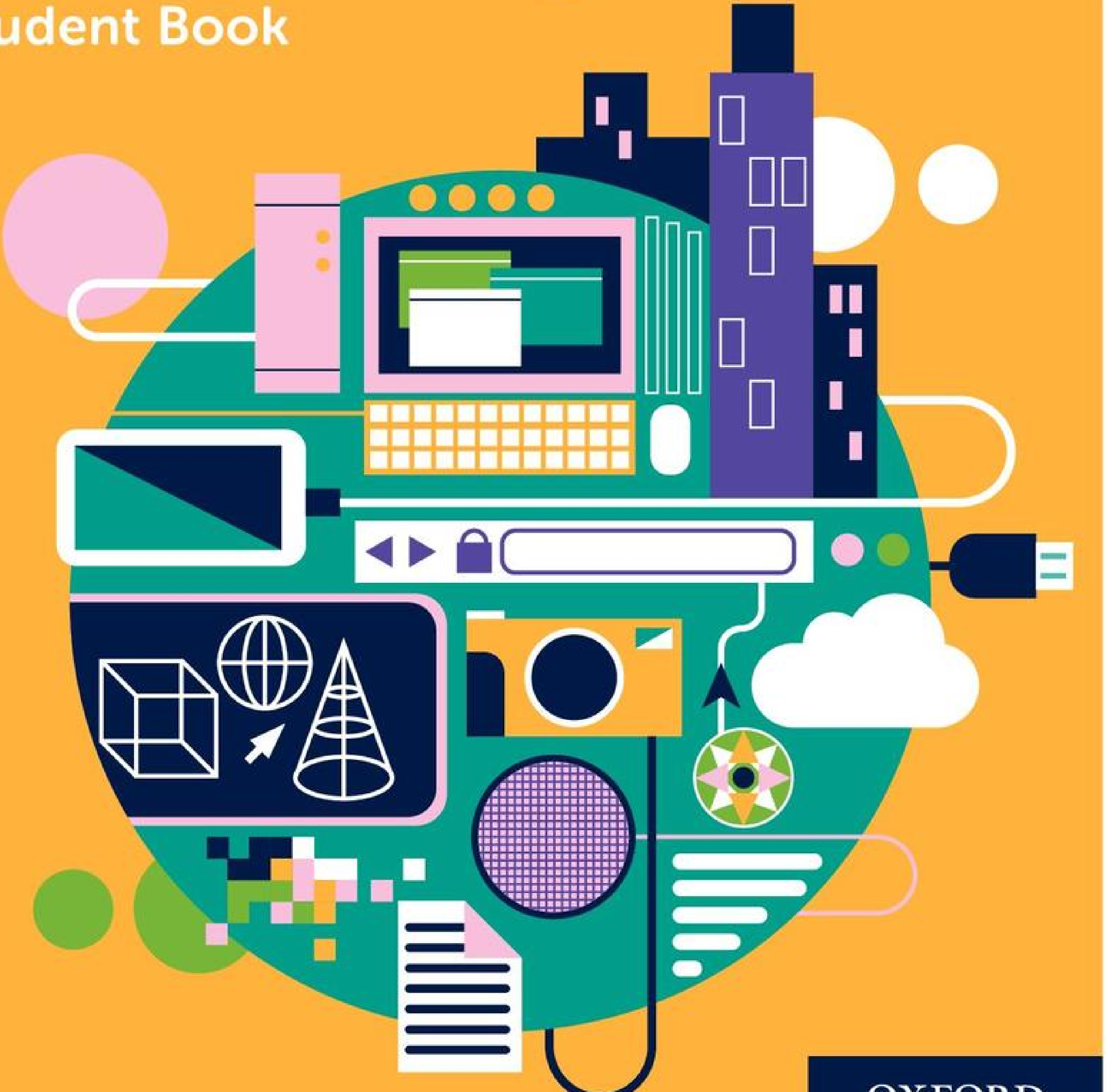
Oxford International Lower Secondary

7

Computing

Student Book



OXFORD

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Computing

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OXFORD

Contents

Introduction

Delivering computing to young learners

Oxford International Primary and Lower Secondary Computing is a complete syllabus for computing education for ages 5–14 (Years 1–9). By following the program of learning set out in this series, teachers can feel reassured that their students have access to the computing skills and understanding that they need for their future education.

Find out more at:
www.oxfordsecondary.com/computing.

Structure of the book

This book is divided into six chapters, for Year 7 (ages 11–12).

1. **The nature of technology:** Introduction to binary numbers, conversion and addition
2. **Digital literacy:** Understanding how to be responsible and avoid risks and dangers on the internet
3. **Computational thinking:** Using different programming languages and understanding how commands work
4. **Programming:** Using if structures in Python and finding and fixing errors
5. **Multimedia:** Planning, recording and editing a podcast
6. **Numbers and data:** Storing data in a data table and checking for errors

What you will find in each unit

- Introduction: An unplugged activity and a class discussion help students to start thinking about the topic.
- Lessons: Six lessons guide students through activity-based learning.
- Check what you know: A test and activities allow you to measure students' progress.

What you will find in the lessons

Although each lesson is unique, they have common features: learning outcomes for each lesson are set out at the start; learning content delivers skills and develops understanding.

Activity Every lesson involves one or more learning activities for the students.

Extra challenge Activities to extend students who are able to do more.

✓ Test A short test of four questions, of progressive difficulty, to check students' understanding of the lesson.

Additional features

You will also find these features throughout the book:

Word cloud The word cloud builds vocabulary by identifying key terms from the unit.

Be creative Suggestions for creative and artistic work.

Explore more Extra tasks that can be taken outside the classroom and into the home.

Digital citizen of the future Advice on using computers responsibly in life.

Glossary Key terms are identified in the text and defined in the glossary at the end.

Assessing student achievement

The final pages in each unit give an opportunity to assess student achievement.

- 🔴 Developing: This acknowledges the achievement of students who find the content challenging but have made progress.
- 🟢 Secure: Students have reached the level set out in the programme for their age group. Most should reach this level.
- 🔵 Extended: This recognises the achievement of students who have developed above-average skills and understanding.

Questions and activities are colour-coded according to achievement level. Self-evaluation advice helps students to check their own progress.

Software to use

We recommend Python for writing programs at this age. For other lessons, teachers can use any suitable software, for example: Microsoft Office; Google Drive software; LibreOffice; any web browser.

Source files

🌐 You will see this symbol on some of the pages.

This means that there are extra files you can access to help with the learning activities. For example, half-completed Python programs or spreadsheet files.

To access the files, click 'Download resources' at:
www.oxfordsecondary.com/computing.

Teacher's Guides

For more on these topics, look at the Teacher's Guide that accompanies this book.

1 The nature of technology: Storing digital data

You will learn

- how text, images and audio can be stored as digital data by a computer
- how to convert between binary and decimal numbers
- how to add binary numbers.

A computer stores data in digital files. A digital file only contains the characters zero and one. In this unit you will learn how text, photographs and images can be turned into digital data so that they can be stored on a computer. You will convert everyday decimal numbers into digital data. You will use codes that will help you understand how computers store text as numbers. You will create simple images and convert them into digital data in the same way as a computer. You will discover how digital sound and video are created.

Talk about...

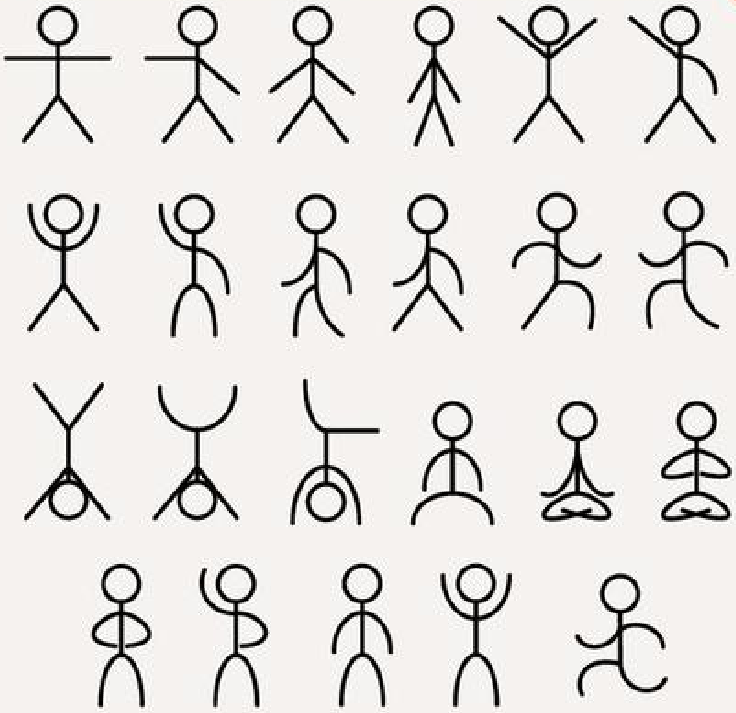
More of our personal data is being stored on the internet than ever before. We choose to store some of that information ourselves on social media sites. Governments, banks and online retailers save information about us online. Do you worry about your data being stored on the internet? Is your data safe?

Curriculum reference: Describe how different types of data can be represented in binary digital form; Convert between decimal and binary integers; Perform simple binary additions

Unplugged

Video and animation are created by showing a series of still images very quickly, one after the other. Create your own animation using a flick book. You will need 15 to 20 strips of paper stapled together. Draw a simple image on the first strip then change it slightly on each of the following strips.

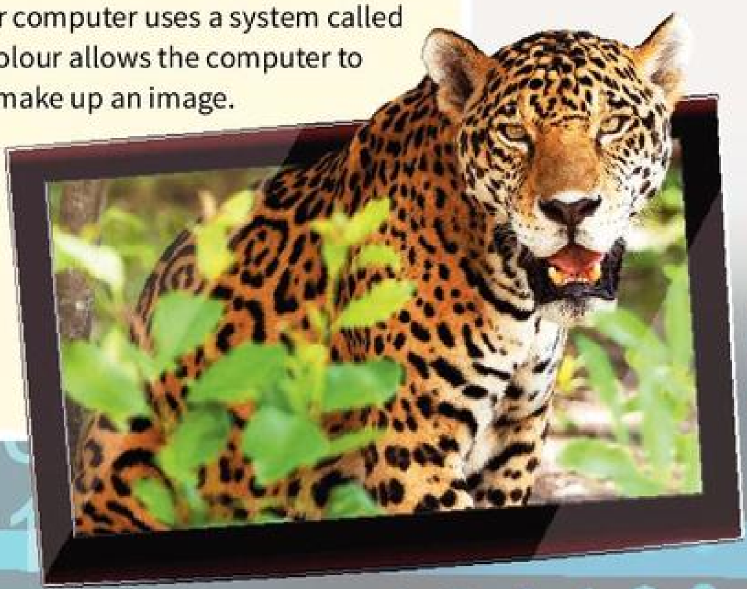
An easy animation to draw is a bouncing ball. If you are feeling more creative, draw a dancing stick character. When you have finished, flick through the paper strips to animate your drawing.



Did you know?

Computers and other digital devices such as televisions display realistic-looking photographs and video images. Your computer uses a system called true colour to create realistic images. True colour allows the computer to store information about all the shades that make up an image.

True colour allows a computer to use more than 17 million colours in an image. That is more colours than most humans can see. Storing the information about a single true colour takes up the same amount of space as the computer uses to store the word ‘red’.



binary digital data bit

byte code ASCII media

pixel true colour sampling

Unicode

1.1 Digital data

In this lesson

You will learn:

- what digital data is
- that computers store digital data as binary numbers
- how digital data is used to store numbers, media and instructions.

Spiral back

In Student Book 4 you learned about the different types of computer we can use to help us work and in our leisure time. All computers are digital devices – they store and process digital data. In this unit you will learn what digital data is and how computers use it to store text, images and sound.

Storing data

Humans store data – lots of data. We need to store data so that we can use it again when we need it.

People have stored data since ancient times. Early people stored data about important events by painting images on cave walls and by carving images and hieroglyphics into stone. Later people recorded their history and scientific achievements by writing on scrolls and parchment.

Throughout history, people developed different ways to store data. They developed printing so that they could store text and images in books. They developed vinyl records, tapes and then CDs to store and play music.

In the modern world, people use computers to store and process data. Most of the data that people use today is stored in a format that computers can use.

What is digital data?

When you communicate in English, you use letters and numbers. You use 26 letters and 10 digits, zero to nine. You also use punctuation characters such as the comma and full stop. You combine these characters to make words and sentences.

A computer stores data using only digits. Data that is stored using digits is called **digital data**. The computer uses only two digits: the numbers zero (0) and one (1).

Every file stored on a computer is made up of zeros and ones. A computer can use digital data files to store text, images, video or audio.

What does a computer use digital data for?

The 1s and 0s inside the computer can be used to store:

- yes and no (or true and false)
- numbers
- instructions that tell the computer what to do
- other digital content such as text, images and sounds.

Binary numbers

When you do use maths to solve day-to-day problems, you use the decimal number system. The decimal system has 10 different digits: the digits 0 to 9. The 'dec' in the word 'decimal' means 10. Some people think that we started to use the decimal system because we use our 10 fingers to count with.

The number system that a computer uses has two different digits: 0 and 1. This is called the **binary** number system. The 'bi' in the word 'binary' means two.

A computer uses binary to store numbers.

Binary numbers are used in calculations in the same way as decimal values. The table shows some example values written as both decimal and binary numbers. They look different but they mean the same thing.

Decimal and binary numbers

Decimal	Binary
1	1
8	1000
18	10010
100	1100100

Activity

Look at the table of binary and decimal numbers. Describe any differences and similarities between decimal numbers and binary numbers that you notice.

Storing text using binary numbers

A computer uses binary to store media. Binary can store text, images, sound and even video. When a computer uses binary to store media it uses codes.

To a computer the word 'Hello' looks like this: 01001000 01100101 01101100 01101100 01101111.

Each set of eight digits is a code for a letter. The code for 'H' is 01001000. The code for 'l' is 01101100. The code for 'l' is used twice in the binary word because there are two 'l's in 'Hello'.

01001000	01100101	01101100	01101100	01101111
H	**e**	**l**	**l**	**o**

In an image, codes are used to represent colours. In a music file, codes can be used to represent different instruments. Complex photographs and music files are all stored as zeros and ones.

Activity

Using the binary number codes in the word 'Hello', translate the word below into English.

01001000 01101111 01101100 01100101

Storing instructions using binary numbers

The instructions in computer programs are stored in binary. In Unit 3 you will write computer programs. The instructions are written using human alphabets and symbols. The instructions in a program must be converted into binary so that the computer can store and use them. Each binary instruction tells the computer to do a simple task.

Activity

Your task is to program a robot to find its way through a maze. There are just four simple instructions that you can give to the robot. These instructions tell the robot which direction to move:

- one step left
- one step right
- one step up
- one step down.

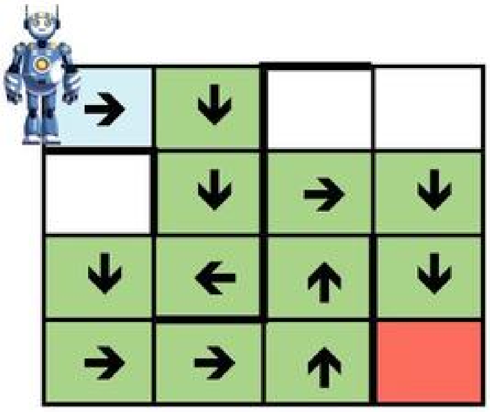
The binary codes for these instructions are shown in the table on the right.

Action	Code
One step left	00
One step right	01
One step up	10
One step down	10

Use the binary codes to write the program for the robot. Your program should follow the arrows shown in the diagram below to follow the green path through the maze from the blue square to the red square. The first five instructions are:

01, 11, 11, 00, 11

These instructions mean: 'Move one step right. Move one step down. Move one step down. Move one step left. Move one step down.'



Complete the list of instructions to guide the robot to the red square.

Why do computers use digital data?

Computers are powered by microprocessors. The microprocessor is the 'brain' of a computer. A microprocessor is made up of millions of tiny electronic switches. The switches in a microprocessor are like any other switch. A switch can either be on or off.

A microprocessor is called a **digital** device because it can only understand the two switch positions – on and off. The on and off positions can be shown as 1 and 0 in binary. You have already learned that digital data is made up of 1s and 0s. That is why a digital microprocessor can read digital data.

Extra challenge

Think about what you have learned in your computing course over the last year. List examples of activities and assignments where you have stored data as values, media and instructions to the computer.

✓ Test

1 Write down the two digits used in the binary number system.

2 Write down the eight extra digits used in the decimal system that are not used in binary.

3 In your own words, explain what digital data is.

4 Describe three things a computer stores as binary code.

1.2 Reading binary numbers

In this lesson

You will learn:

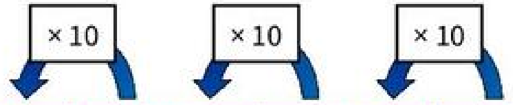
- about bits and bytes
- how to convert binary numbers into decimal numbers
- the meaning of base 2 and base 10.

Understanding binary

Base 10 and base 2 numbers

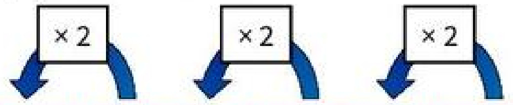
In the last lesson you learned that a computer must store everything it processes as digital data. You learned that you can use the binary number system to understand what digital data looks like. You also compared some binary numbers to decimal numbers.

The decimal number system uses 10 digits (0 to 9). The value of each column in a decimal number is 10 times greater than the previous column. Another name for the decimal system is **base 10**.



1000s	100s	10s	Units
2	5	4	3

The binary number system uses two digits (0 and 1). The value of each column in a binary number is 2 times greater than the previous column. Another name for the binary system is **base 2**.



8s	4s	2s	Units
1	1	0	1

Activity

Other number systems are sometimes used in computing. One system is octal. Octal is the base 8 number system. Use the information you have learned about base 2 and base 10 to answer these questions:

- How many digits does the base 8 system use?
- What are those digits?
- What are the values of the first four columns in the base 8 number system? Draw a table to show your answer.

How to read binary numbers

You can use your knowledge of base 2 to read binary numbers. The easiest way to understand a binary number is to convert the binary number into a decimal number. You use the decimal system every day, so it is much easier to understand.

The binary number shown in the table above is 1101. Here is an easy way to convert the number into decimal.

1 Draw a table like the ones in the example on the previous page. It must have enough columns to hold the binary number you want to convert.

2 In the first row of the table, write the value of each column. Start with units in the right-hand column then multiply by 2 each time you move from right to left.

8s	4s	2s	Units

3 Write the number you want to convert in the second row of your table

8s	4s	2s	Units
1	1	0	1

4 Multiply each digit in the number you want to convert by the column value.

1 × 8 = **8** 1 × 4 = **4** 0 × 2 = **0** 1 × 1 = **1**

5 Add the results together. The total is the value of the binary number as a decimal number.

8 + 4 + 0 + 1 = **13**

1101 in binary is 13 in decimal.

Activity

Convert these binary numbers into decimal numbers.

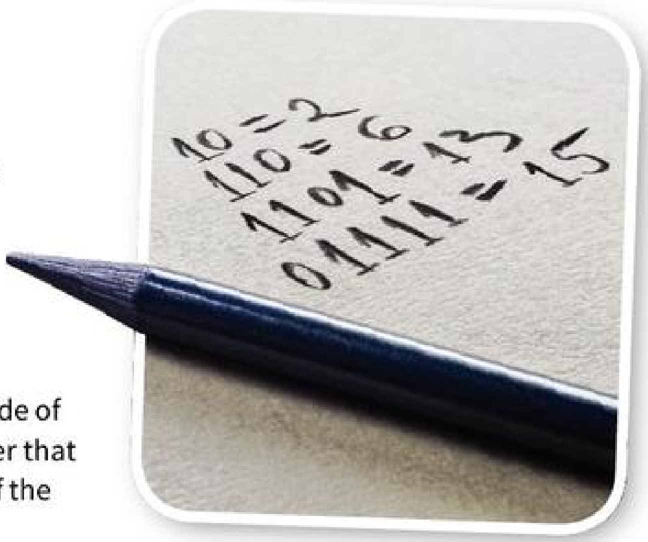
a 0111

b 1001

c 11001

d 111001

You will need to add more columns to the left-hand side of your table for the numbers in parts c and d. Remember that the value of each column must be 2 times the value of the column to the right.



Bits and bytes

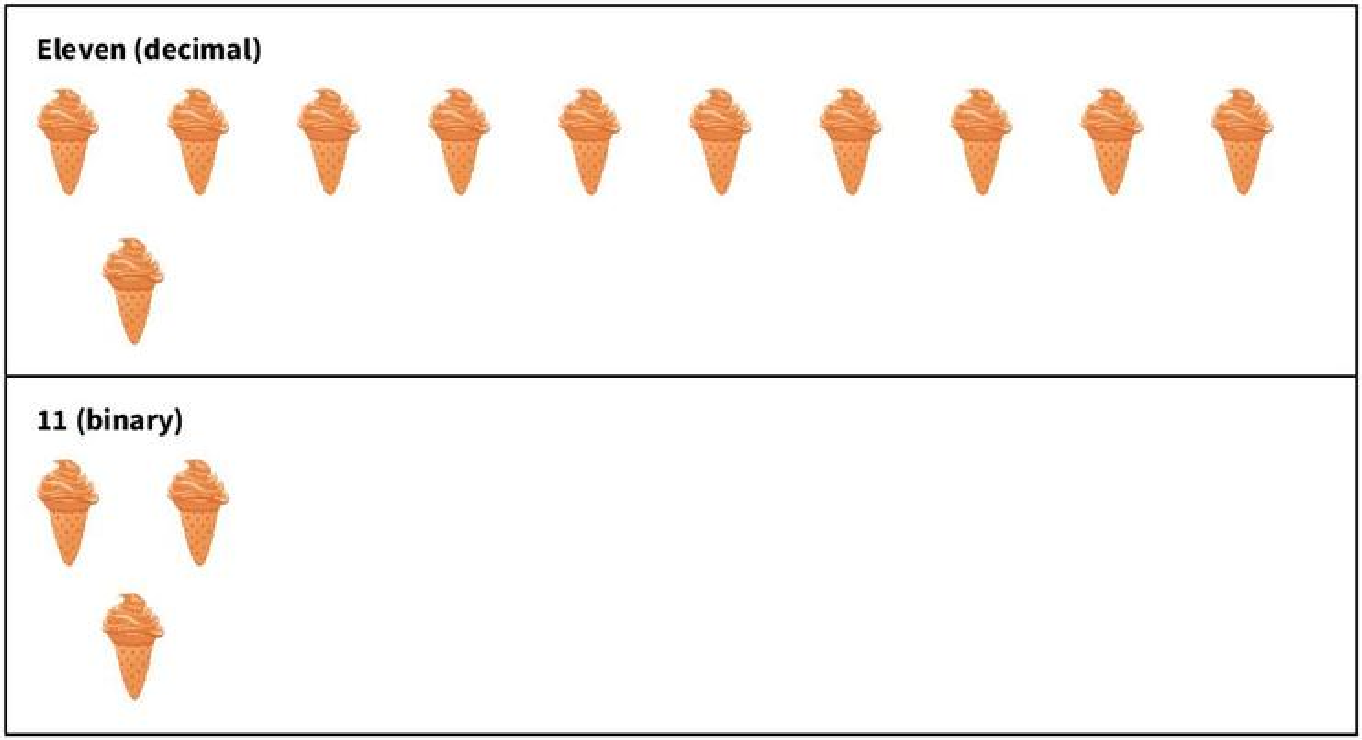
Each digit in a binary number is called a **bit**. There are four bits in the binary number 1101. The word bit is short for '**b**inary dig**it**' – the first letter of 'binary' combined with the last two letters of 'digit'.

A bit isn't very useful on its own. It can only store one of two values: 0 or 1. To make binary more useful, computers group bits together. Eight bits grouped together is called a **byte**. Here are some examples of data stored in a byte: 11111111, 00000000, 00110101.

When you write a byte you must show all eight digits in the number, even if you have to start the number with zeros. The value zero as a byte is 00000000.

The language of numbers

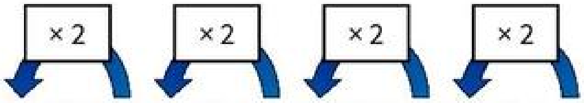
'Ten' and 'eleven' are examples of names of numbers in the decimal system. Every number in the decimal system has a name. Numbers are not given names in binary. The binary number 11 is called 'one-one'. The decimal number eleven and the binary number 11 are different numbers.



Activity

Copy the table below and complete the column headings.

Then use the table to convert the byte 01100110 into decimal.



?	?	?	?	8s	4s	2s	Units
0	1	1	0	0	1	1	0

A binary to decimal shortcut

Base 2 is very easy to convert into decimal because it only uses two digits: 0 and 1. When you feel confident using the method of converting binary into decimal you have learned in this lesson, you can try this shortcut:

Use the byte table you created in the last activity. Start at the right of the binary number. Look at each digit in turn. Add together the place value of every column that contains a 1. With practice, you will soon learn the column heading values and be able to convert binary numbers in your head. Try this shortcut method when you complete the next activity.

Activity

The table below contains the values 0 to 9 written as binary numbers. The numbers are in random order. Rewrite the list of numbers so that they are in order from zero to nine.

0011	0010	1000	0000	0110	0111	0101	0001	0100	1001

Extra challenge

Work with a partner or in two small teams.

Write each of the binary numbers from the table in the last activity on a separate card. Mix the cards up and lay them out facing your partner. Now set your partner some challenges.

- Point to a card and ask your partner to tell you the decimal value of the card.
- Pick three cards at random and ask your partner to place them in numerical order.
- Ask your partner to pick two cards that add up to the decimal value 6 (or choose another value).

Test

1 Convert the binary number 1001 into decimal.

2 a What is a byte?

b Convert the byte 11001011 into decimal.

3 Look at this binary number: 00100010. Explain why the 1 in column 6 has a different value to the 1 in column 2.

4 Explain what base 2 means.

Explore more

Teach a friend or family member how to read binary numbers. Challenge them to a contest.

1.3 Adding in binary

In this lesson

You will learn:

- how to do simple addition in binary
- what overflow means when adding in binary.

When digital data is stored as a value it can be used in calculations. For example, you have used spreadsheets in this course. When you enter a formula such as =A3+B3 in a spreadsheet cell your computer will carry out binary addition. You have also learned programming in this course. When your computer moves a sprite on screen it uses binary addition to calculate a new position.

In this lesson you will learn how to do simple addition using binary.

Simple addition in decimal

To do addition in binary you use the same method as addition in decimal. It will help to look at an example of how addition works in decimal before moving on to binary addition.

If you lay out the addition in a table like the one on the right, it is easier to follow what happens when you add the numbers. You use the first two rows in the table for the numbers you will add together. You use the row at the bottom to record the sum. You use the shaded row to hold any values that you need to carry.

Number 1			
Number 2			
Carry			
Sum			

Example: decimal addition

In this example you will add together the numbers 262 and 174.

When you do an addition, you add together the numbers in each column from right to left and record the sum.

Step 1: Add the Units column: Add 2 and 4 together. Think of the sum as being '06'. This will help when you do binary addition later.

Write '06' in the table. Enter the 0 in the carry row of the 10s column. Enter the 6 in the sum row of the Units column.

	100s	**10s**	**Units**
Number 1	2	6	2
Number 2	1	7	4
Carry		0	
Sum			**6**

Step 2: Add the 10s column: The digits in this column add up to 13. Enter the 1 in the carry row of the 100s column. Enter the 3 in the sum row of the 10s column.

	100s	**10s**	**Units**
Number 1	2	6	2
Number 2	1	7	4
Carry	1	0	
Sum		**3**	**6**

Step 3: Add the 100s column: The digits in this column add up to 04. There is nothing to carry. Enter the 4 in the sum row of the 100s column. This completes the addition.

262 + 174 = 436.

	100s	**10s**	**Units**
Number 1	2	6	2
Number 2	1	7	4
Carry	1	0	
Sum	**4**	**3**	**6**

Activity

Draw a copy of the table used in the previous example. Use it to add 729 and 252.

Adding in binary

You use the same method to add two binary numbers together. Adding in binary seems more difficult because you are not so familiar with binary numbers. There are four rules that will help you to do binary addition.

Rule 1: 0 + 0 = **00**

Number 1		0
Number 2		0
Carry	0	**0**
Sum		0

Rule 2: 0 + 1 = **01**

Number 1		0
Number 2		1
Carry	0	**0**
Sum		1

Rule 3: 1 + 1 = **10**

Number 1		1
Number 2		1
Carry	1	**0**
Sum		0

Rule 4: 1 + 1 + 1 = **11**

Number 1		1
Number 2		1
Carry	1	**1**
Sum		1

You can use these rules to add any two binary numbers. Write the two numbers one above the other so the bits line up. Start with the bits in the Units column (on the right). Look down the column. What bits do you see? It will be one of these possibilities:

- 0 + 0
- 1 + 0
- 1 + 1

The rules of binary addition will tell you the answer. Write in the answer and any carry bit.

Now go to the next column (the 2s column). Look down the column, including any carry bit. What bits do you see? The same possibilities as before. Because of the carry bit there is another possibility:

- 1 + 1 + 1

Write in the answer plus any carry bit. Do the same for every column until you have added every column.

You will see an example on the next page.

Example: binary addition

In this example you will add the binary numbers 0011 and 1011. You will use the four rules to help you with your binary addition.

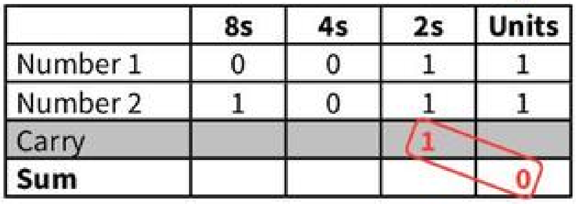
Step 1: **Add the Units column:** Number 1 and Number 2 both have a 1 in the Units column. Rule 3 says 1 + 1 = **10**. Enter the 1 in the carry row of the 2s column. Enter the 0 in the sum row of the Units column.

Step 2: **Add the 2s column:** Number 1 and Number 2 both have a 1 in the 2s column. There is also a 1 in the carry row. Rule 4 says 1 + 1 + 1 = **11**. Enter the first 1 in the carry row of the 4s column. Enter the second 1 in the sum row of the 2s column.

Step 3: **Add the 4s column:** Number 1 and Number 2 both have a 0 in the 4s column. There is a 1 in the carry row. Rule 2 says 0 + 1 = **01**. Enter 0 in the carry row of the 8s column. Enter 1 in the sum row of the 4s column.

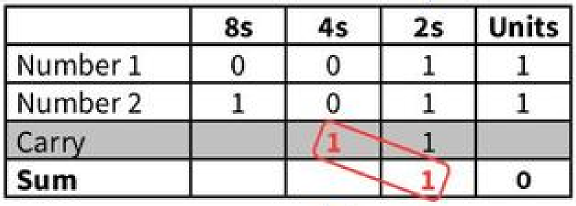
Step 4: **Add the 8s column:** Rule 2 says 0 + 1 = **01**. You don't need to enter the 0 because there are no more columns. Enter 1 in the sum row of the 8s column.

Step 1 Rule 3: 1 + 1 = 10



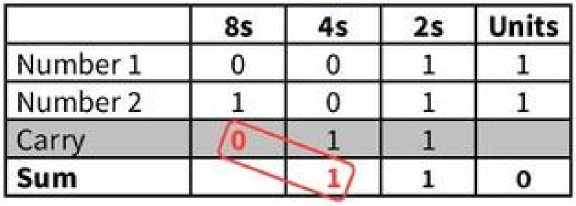
	8s	4s	2s	Units
Number 1	0	0	1	1
Number 2	1	0	1	1
Carry			1	
Sum				0

Step 2 Rule 4: 1 + 1 + 1 = 11



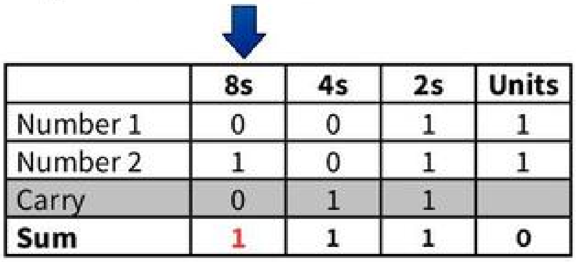
	8s	4s	2s	Units
Number 1	0	0	1	1
Number 2	1	0	1	1
Carry		1	1	
Sum			1	0

Step 3 Rule 2: 0 + 1 = 01



	8s	4s	2s	Units
Number 1	0	0	1	1
Number 2	1	0	1	1
Carry	0	1	1	
Sum		1	1	0

Step 4 Rule 2: 0 + 1 = 01



	8s	4s	2s	Units
Number 1	0	0	1	1
Number 2	1	0	1	1
Carry	0	1	1	
Sum	1	1	1	0

Activity

A student wanted to add 1010 + 0010. They put the numbers into the addition table.

	8s	4s	2s	Units
Number 1	1	0	1	0
Number 2	0	0	1	0
Carry				
Sum				

Copy the table. Use the rules of binary addition to complete the table and find the sum.

Now use the same method to add 0011 + 0111.