Here you will find the answers to the ‘Check your understanding’ questions and the ‘Now test yourself’ exercises in the book.

Unit 1

Hardware (page 3)

1 Any five from
- printer
- central processing unit (CPU)
- soundcard
- motherboard
- graphics processing unit (GPU)
- scanner
- storage units (primary and secondary)
- mouse, roller ball, touch pad
- sip-puff tube, foot mouse, eye-typer
- microphone
- monitor
- speaker.

2 Von Neumann model
   Harvard model

3 CIR Current Instruction Register
   MAR Memory Address Register
   ACC Accumulator
   PC Program Counter

Hardware (page 5)

1
   
   2 RISC processors can process a limited number of relatively simple instructions.
   CISC processors can process a large number of complex instructions.

3 Any three from
- clock speed
- using multiple cores
- efficient programming
- number of applications running
- amount of RAM.

Hardware (page 7)

<table>
<thead>
<tr>
<th>Device</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keyboard</td>
<td>Typing in data to a computer</td>
</tr>
<tr>
<td>Scanner</td>
<td>Copying documents</td>
</tr>
<tr>
<td>Foot mouse</td>
<td>Useful for someone who cannot move their arms</td>
</tr>
<tr>
<td>Microphone</td>
<td>Entering sounds into the computer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keyboard</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Scanner</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Foot mouse</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Printer</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Roller ball</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Monitor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3 a) RAM is volatile

Hardware (page 9)

1 1024
2 One character
3 It helps speed up processing when applications are using 3D graphics and video animation.

4 Any one from
- mobile phones
- video game consoles
- digital cameras
- DVD players
- GPS
- microwave ovens.

There are many other answers. If you are not sure that your answer is correct, check with your teacher.

Now test yourself (page 9)

1 a) The graphics processor unit (GPU) is a specialised chip and circuit board which helps processing when applications are using 3D graphics and video animation. The GPU renders the images, animations and video for the computer screen. It helps make the images appearing on screen faster and smoother to give the best experience in games and movies.
b) An embedded system is a combination of software and hardware created for a specific purpose. A PC is a general-purpose machine designed to carry out multiple tasks. Embedded systems are made for a specific use and are often mass produced. They consist of a program on ROM or flash disk running a simple machine.

2 a) 1 KB is 1024 bytes
   2 KB is $2 \times 1024 = 2048$ bytes
   If one character is one byte, then 2048 is the number of characters.

b) i) CD ROMs usually have a storage capacity of around 700 MB. 8 GB is 8192 MB and so the CD ROM would not have enough memory.

   ii) One from
   • DVD
   • Blu-ray
   • hard drive.

Logical operations (page 11)

1 AND 1 = 1
NOT 0 = 1
1 XOR 1 = 0
0 OR 0 = 0

Logical operations (page 12)

1 Step 1

<table>
<thead>
<tr>
<th>Window open</th>
<th>Door open</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>NO</td>
<td>No Alarm</td>
</tr>
<tr>
<td>NO</td>
<td>YES</td>
<td>Alarm</td>
</tr>
<tr>
<td>YES</td>
<td>NO</td>
<td>Alarm</td>
</tr>
<tr>
<td>YES</td>
<td>YES</td>
<td>Alarm</td>
</tr>
</tbody>
</table>

Step 2

<table>
<thead>
<tr>
<th>Window open</th>
<th>Door open</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Step 3

This can be simplified to $A \ OR \ B = C$

Logical operations (page 14)

1 $C = B \ OR \ (A \ AND \ B)$

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>A AND B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
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</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Now test yourself (page 14)

1

```
<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>Å</th>
<th>Å + B</th>
<th>B . (Å + B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
```

It can be seen from the table that the last column is the same as the B column. Therefore $B . (Å + B) = B$

2 $A + (B + C)$

3

```
<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
```

Communication (page 18)

1 Any three from
   • bus
   • mesh
   • ring
   • star.

2 Ask your teacher or the network manager if you have one in your school.

3 Any three from:
   • Hardware can be shared (e.g. several computers can use the same printer).
• Software can be shared (e.g. a number of workstations can all load up the same program from a file server).
• Data can be shared (e.g. a number of computers can access the same database stored on a file server).
• Computers may communicate between each other with messages or email.
• Administration is centralised.
• Users can log into any networked device.

Communication (page 20)
<table>
<thead>
<tr>
<th>Hardware</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Router</td>
<td>Forwards packets of data along a network. Often used where two networks are connected. Determines best path for the packets.</td>
</tr>
<tr>
<td>Hub</td>
<td>A connection point between cables in a network.</td>
</tr>
<tr>
<td>Switch</td>
<td>Filters and forwards data packets to intended destination.</td>
</tr>
<tr>
<td>Bridge</td>
<td>Connects one LAN to another.</td>
</tr>
<tr>
<td>Gateway</td>
<td>Connects a LAN to a WAN such as the internet.</td>
</tr>
</tbody>
</table>

Communication (page 22)
1 Another way to revise this is to ask a friend to test you.
2 • Physical layer
   • Data link layer
   • Network layer
   • Transport layer
   • Application layer
3 A protocol is a set of rules to help communication between computers so that different electronic devices can understand each other.
4 One device asks if they can communicate and the other device says, ‘go ahead’.

Now test yourself (page 23)
1 a) i) Star

   ![Diagram of Star Network]

   ii) Mesh

   ![Diagram of Mesh Network]

   b) • Bus
      • Ring
2 a) • Physical layer
     • Data link layer
     • Network layer
     • Transport layer
     • Application layer

   b) Any three from:
   • If changes are made to one layer, the impact on the other layers is minimised.
   • Protocol designers can work on a layer without worrying about how any new implementations may affect other layers.
   • It reduces a complex problem into several smaller parts, making understanding the actions of each layer easier.
   • It makes troubleshooting easier to carry out as only the layer causing the problem needs working on.
   • It helps those developing products to make sure their product works with the other layers.

3 • The address of its destination, so the packet knows where to go.
• Information about how many packets there are in the message, so the receiver knows when the message is complete
• Information explaining where the packet fits into the message

Organisation and structure of data (page 27, top)

<table>
<thead>
<tr>
<th>Denary</th>
<th>Binary</th>
<th>Hexadecimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>142</td>
<td>10001110</td>
<td>8E</td>
</tr>
<tr>
<td>156</td>
<td>10011100</td>
<td>9C</td>
</tr>
<tr>
<td>174</td>
<td>10101110</td>
<td>AE</td>
</tr>
<tr>
<td>161</td>
<td>10100001</td>
<td>A1</td>
</tr>
<tr>
<td>2989</td>
<td>101110101101</td>
<td>BAD</td>
</tr>
<tr>
<td>122</td>
<td>1111010</td>
<td>?A</td>
</tr>
</tbody>
</table>

Organisation and structure of data (page 27, bottom)

<table>
<thead>
<tr>
<th>Denary</th>
<th>Binary</th>
<th>Hexadecimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>128</td>
<td>00001010</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>00010100</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>00001100</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>00100000</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>00000000</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>00000000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>00000000</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>00000000</td>
<td></td>
</tr>
</tbody>
</table>

Organisation and structure of data (page 28)

<table>
<thead>
<tr>
<th>Denary</th>
<th>Binary</th>
<th>Hexadecimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>000110010</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1100010</td>
<td></td>
</tr>
</tbody>
</table>
Organisation and structure of data (page 29)

Try different types of files such as images, sound and text and see the surprising metadata that is available. If you cannot find any then check with your teacher that you are doing the search correctly.

Now test yourself (page 33)

1

<table>
<thead>
<tr>
<th>Field</th>
<th>Data type</th>
<th>Sample data</th>
<th>Validation check</th>
</tr>
</thead>
<tbody>
<tr>
<td>First name</td>
<td>String</td>
<td>John</td>
<td>Presence check</td>
</tr>
<tr>
<td>Last name</td>
<td>String</td>
<td>Evans</td>
<td>Presence check</td>
</tr>
<tr>
<td>Form</td>
<td>String</td>
<td>3F</td>
<td>Lookup check</td>
</tr>
<tr>
<td>House</td>
<td>String</td>
<td>Cardiff</td>
<td>Lookup check</td>
</tr>
<tr>
<td>Gender</td>
<td>Boolean</td>
<td>Male</td>
<td>Lookup check</td>
</tr>
<tr>
<td>Number of siblings in school</td>
<td>Integer</td>
<td>2</td>
<td>Range check</td>
</tr>
</tbody>
</table>

2 Raster graphics are made up of pixels (dots), where each pixel has a position and a colour. Vector graphics consist of equations that describe the relative distance of a point from the point of origin. Raster graphics cannot be scaled up without a loss of quality. This is known as pixellation. Vector graphics can be enlarged to any size without any loss in quality.

System software (page 36)

1 A command line interface is designed to allow a user to type in commands at a prompt. The operating system will then execute that command. A graphical user interface is an intuitive interface. It is a user-friendly system, meaning that most people are able to operate the system without too much training, whereas with the CLI they must learn the commands.

2 What did you see? Were you surprised? If you did not have success with this task ask the teacher to help.

3 Did you notice the different shapes? If you are not sure why the shapes change talk about it with your teacher.

System software (page 37)

Always ask the teacher if there is something you see that you do not understand.

Now test yourself (page 38)

1 Provides
- windows – a rectangular area of the screen in which an application runs
- icons – small pictures on the screen to help identify the program or shortcut
- menus – where lists of options are displayed
- pointers – an image moved across the screen by a mouse.

2

<table>
<thead>
<tr>
<th>Task</th>
<th>True</th>
<th>False</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spellchecking</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Managing the printer</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Dealing with errors</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Sorting records</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Setting tabs</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Handling the storage of data</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Managing emails</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Organising resources</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

3 • Compression software reduces the sizes of files for storage or transmission and decompresses compressed files to restore them to ordinary use.
• Defragmentation software rearranges the data on a disc to make it more efficient by identifying where gaps begin to appear as files are added and deleted on a disk and by moving the parts of files around so as to make the sections of a file contiguous as sometimes there is no space big enough on the disk to hold it.

4 An operating system will manage
- peripherals, such as keyboards, mice, printers, monitors and other input or output devices attached to the computer
- printing and scanning, using spooling
- storage devices, such as disc drives, DVDs and flash memory
- immediate access stores, such as RAM and ROM
- utility programs, such as disk defragmenters
- all the processes currently taking place in the computer
- security of the computer against virus attacks, for instance.

5 • The operating system helps the user by hiding the complexities of hardware from the user.
• It manages the hardware resources including the processors, memory, data storage and input and output devices.
• It shares the input and between many programs using the CPU.
• With the help of anti-virus programs, it works to keep the computer safe.
• With the help of utility programs, it allows you to keep the computer running smoothly by, for instance, defragmenting the hard drive.

**Principles of programming (page 41)**

<table>
<thead>
<tr>
<th>High-level</th>
<th>Low-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>E</td>
<td>C</td>
</tr>
<tr>
<td>F</td>
<td>D</td>
</tr>
</tbody>
</table>

**Now test yourself (page 41)**

1 a) Both are low-level languages, but machine code uses pure binary numbers while assembly code uses mnemonics.

b) Java is an example of a high-level language. Programmers prefer to use high-level languages because they are generally easier to use and understand than low-level languages. They are problem orientated, which facilitates creating programs for a particular use or problem. They tend to have built-in functions and single commands that can carry out complex tasks. They are like natural spoken languages and it is possible to use meaningful and complex variable names.

**Now test yourself (page 43)**

1 a) Three from:
   - Trace – prints out or displays the order in which the lines of a program are executed, and possibly the values of variables as the program is being run.
   - Break point – interrupts a program at a specific line allowing the programmer to check the current value of a variable.
   - Variable watch – also displays the current value of any variable.
   - Single stepping – allows the program code to be executed one line at a time.
   - Store dump – displays the contents of all the stores used in the program.
   - Memory inspector – displays the contents of all the stores in a defined section of memory.
   - Error diagnostics – displays error messages to help the programmer diagnose what has gone wrong.

b) Your IDE will almost certainly have some or all of the tools mentioned in part a) above. Well done for programming using an IDE!

**Now test yourself (page 46)**

1 a) Two from:
   - Syntax errors – occur when the program is being compiled, such as by not closing brackets.
   - Linking errors – may occur if a compiled program is linked to library routines that do not exist.
   - Run-time errors – occur when the program is running. For example, a program is asked to display the price of an item but that item cannot be found.

b) i) Lexical analysis – All comments and spaces are removed, keywords are replaced by ‘tokens’ and a symbol table is created which holds the addresses of variables, labels and subroutines.

ii) Syntax analysis – Each statement is checked against the rules of syntax for the assembler, such as spelling or grammar, and that the sequence of characters, symbols, items or tokens obey the rules of syntax.

iii) Semantic analysis – Checking that the statements, structure and data types obey the rules of the compiler and making sure that variables used in the program have been declared.

iv) Code generation – Generating the machine code.

v) Optimisation – Attempting to reduce the execution time of the object program.

c) A compiler translates a complete program written in a high-level language, known as the source code, into machine code in one go without stopping.

The advantages of a compiler are that:
   - a compiled program runs faster than an interpreted program
   - it checks all lines of coding whereas an interpreter only checks the one being executed.

The disadvantages are that:
   - you only see the errors at the end, making the program harder to debug
   - the process takes a long time as the whole program has to be recompiled every time an error is corrected.

**Security and data management (page 49)**

1 A strong password contains a mixture of upper and lowercase letters, digits and special symbols, is changed regularly, is not related to any personal details like dates of birth or pet names and is never revealed to anyone.

2 **Compression ratio** = \( \frac{\text{original file size}}{\text{compressed file size}} \)

The compression ratio is 7:1 which means that the original file is seven times bigger than the compressed one.

\[ 50 \times 7 = 350 \]

The original file was 350 KB.
Now test yourself (page 51)

1 a) The original bit depth is reduced to remove data and reduce the file size. This means, for instance, in an MP3 file the number of bits representing the sounds is reduced but not enough to fool the human ear. This will make the file size smaller.

b) Compression ratio = \( \frac{\text{original file size}}{\text{compressed file size}} \)

\[
= \frac{640}{64} = 10:1
\]

2 a) • Hacking, where data may be deliberately changed, stolen or deleted by unauthorised people. This can be prevented by using strong passwords, incorporating a firewall and making sure that physical security of the system is good.

• A computer virus may affect the data or running of the computer. This can be prevented by using up-to-date anti-virus software.

b) Dangers can arise from the fact that all files are held on a central file server which is vulnerable to hacking. To keep the data safe precautions must be taken, such as setting access rights to files, choosing strong passwords that are changed regularly and installing anti-virus software that is kept up to date and used constantly.

A network administrator or manager is employed to make sure these precautions are initiated and obeyed.

A firewall, software that will block unexpected connections coming in to the network, is used.

The network manager will make sure that rules are in place to make sure that user IDs are legitimate, belong to members of the school and that passwords are strong.

The network manager will also provide secure backups of the data held and also produce and manage disaster recovery policies.

Ethical, legal and environmental impacts (page 54)

1 • Programmers are needed to create apps, webpages or other programs.

• Network managers are needed to manage networks in organisations.

• Computer technicians are needed to keep computers running and updated.

• Designers, CAD workers, publishers and any other jobs which involve using computers at work.

2 • More people are working from home, saving on the expenditure of fuel and travel time.

• There is more time for leisure, travel and shopping.

• Digital devices are making it easier to monitor what people are doing using CCTV cameras, monitoring phone calls, emails and text messages.

• People use ‘electronic money’ more and real money less, such as credit and debit cards, Apple Pay and online payments. Some banks do not even have branches.

• Mobile phone signals and debit and credit card use can be used to track our movements.

• We use apps like Facebook, YouTube, Twitter and other social media to record events in our lives. We use message services to communicate. This means we spend more time talking on our computers than we do face to face.

• We are becoming less fit because many of the games we play are played sitting down.

Ethical, legal and environmental impacts (page 56)

1 Four from

• people concerned with national security such as GCHQ

• police for the detection of crime

• scientists or historians carrying out scientific or historical research

• companies processing wages, pensions or tax

• people at home where data is used privately for household or recreational reasons.

2 This Act allows the public to access information held by public authorities such as government departments, local authorities and the NHS. By making authorities publish certain information about their activities, including printed documents, computer files, letters, emails, photographs and sound or video recordings, it allows members of the public to check that public authorities have nothing to hide.

3 Sensitive personal data is data that a member of the public may not wish to be widely known since it is private to them. If this data was widely known it could interfere with things like getting a job or getting insurance. Sensitive data includes

• racial or ethnic origin

• religious or philosophical beliefs

• political opinions

• trade union membership

• health

• genetic or biometric data

• sex life or sexual orientation.

Now test yourself (page 57)

1 a) Any two from the list below.

The Computer Misuse Act (1990) is a law that makes it illegal to:

• Gain unauthorised access to files stored on a computer system, including viewing and copying the files.
• Gain unauthorised access to files and use them for criminal activities such as fraud or blackmail.
• Change or delete any files unless authorised to do so – this includes creating or planting viruses.

b) Three items of personal data that an organisation cannot disclose without permission from the list below
- racial or ethnic origin
- religious or philosophical beliefs
- political opinions
- trade union membership
- health
- genetic or biometric data
- sex life or sexual orientation.

Three instances when exceptions can be made from the list below
- national security
- detection of crime
- scientific or historical research
- processing wages, pensions or tax
- data used privately at home for household or recreational reasons.

Unit 2

Problem solving (page 62)

<table>
<thead>
<tr>
<th>Description</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes written by the programmer</td>
<td>decomposition</td>
</tr>
<tr>
<td>Splitting a complex problem into smaller parts</td>
<td>abstraction</td>
</tr>
<tr>
<td>A self-contained subroutine</td>
<td>module</td>
</tr>
<tr>
<td>A way of passing data to a subroutine</td>
<td>interface</td>
</tr>
<tr>
<td>Stripping away redundant information</td>
<td>documentation</td>
</tr>
</tbody>
</table>

Algorithms and programming constructs (pages 67–68)

1 a) c  t  y  output
    0  0  0
    1  4  4
    2 10  6
    3 12  2
    4 19  7

b) To find the average of the first four numbers in the list of inputs.

Now test yourself (page 74)

1 a) i) txt is string
     welcome is string
     welcome = “Hello from Wales”
     txt = “Have a great holiday”
     length = len(welcome)
     output length
     output welcome + txt

ii) txt is string
    welcome is string
    welcome = “Hello from Wales”
    txt = “Have a great holiday”
    length = len(welcome)
    output length
    output mid(welcome,7,4)
b) Answer in pseudo code:

```plaintext
set maximum = 0
set minimum = 0
output “Please type in a number: “
input y
maximum = y
minimum = y
while y <> 0
    if y > maximum
        maximum = y
    end if
    if y < minimum
        minimum = y
    end if
    output “Please type in a number: “
    input y
end while
output “Minimum is “,minimum,” and “,”Maximum is “,maximum
```

Python answer:

```python
maximum = 0
minimum = 0
y = int(input("Type in a number: "))
maximum = y
minimum = y
while y != 0:
    if y > maximum:
        maximum = y
    if y < minimum:
        minimum = y
    y = int(input("Type in a number: "))
    if y == 0:
        break
print("Minimum is ",minimum," and ",maximum)
```

2 a) 8 4 9 3

Compare 8 and 4.  
8 is larger than 4 so they swap places.

```
4 8 9 3
```

Compare 8 and 9.  
9 is larger than 8 so no swap.

```
4 8 9 3
```

Compare 9 and 3.  
9 is larger than 3 so they swap places.

```
4 8 3 9
```

The largest number is now in position

Start from the beginning again

```
4 8 3 9
```

Compare 4 and 8, no swap necessary.

```
4 8 3 9
```

8 is greater than 3 so swap.

-----

b) Choose the middle number and compare it with 4. (Because there are an even number of numbers, we take the one nearest the middle.)

```
8 4 9 3 8 5 7 3
```

4 is less than 8 so discard the 8 and everything to the right.

```
8 4 9 3
```

Choose the middle number and compare it with 4.

```
8 4
```

4 is the correct number and so we can stop.

Programming languages (page 78)

<table>
<thead>
<tr>
<th>Mnemonic code</th>
<th>Description of action</th>
</tr>
</thead>
<tbody>
<tr>
<td>INP</td>
<td>Input a number</td>
</tr>
<tr>
<td>STA Reg1</td>
<td>Store the number in Reg1</td>
</tr>
<tr>
<td>INP</td>
<td>Input a number</td>
</tr>
<tr>
<td>STA Reg2</td>
<td>Store the number in Reg2</td>
</tr>
<tr>
<td>LDA Reg1</td>
<td>Load the accumulator with Reg1</td>
</tr>
<tr>
<td>SUB Reg2</td>
<td>Subtract Reg2</td>
</tr>
<tr>
<td>OUT</td>
<td>Output the result</td>
</tr>
<tr>
<td>HLT</td>
<td>Stop</td>
</tr>
</tbody>
</table>

Now test yourself (page 81)

1

```html
<center> </center>
<title> </title>
<a href = "mailto:isla@email.co.uk">Send mail to Isla</a>
```
### Answers

<table>
<thead>
<tr>
<th>Mnemonic code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>INP</td>
<td>Input the first number</td>
</tr>
<tr>
<td>STA Num1</td>
<td>Store it in store Num1</td>
</tr>
<tr>
<td>INP</td>
<td>Input the second number</td>
</tr>
<tr>
<td>STA Num2</td>
<td>Store it in store Num2</td>
</tr>
<tr>
<td>INP</td>
<td>Input the third number</td>
</tr>
<tr>
<td>STA Num3</td>
<td>Store it in store Num3</td>
</tr>
<tr>
<td>LDA Num1</td>
<td>Load the accumulator with Num1</td>
</tr>
<tr>
<td>ADD Num2</td>
<td>Add Num2 to the accumulator</td>
</tr>
<tr>
<td>ADD Num3</td>
<td>Add Num3 to the accumulator</td>
</tr>
<tr>
<td>OUT</td>
<td>Output the result</td>
</tr>
<tr>
<td>HLT</td>
<td>Stop</td>
</tr>
</tbody>
</table>

- A class is a plan or template for creating objects within a program. Functions and data can be grouped and placed in a class container so that they can be easily accessed.
- An object can get its variables and functions from a class. So if we have a class of Dog, objects such as type of Dog called LabradorDog can be created using the template of class and using all the functions available in class Dog.
- A method is used to implement a behaviour. One class can contain many methods such as running, begging or tailwagging.
- Inheritance allows a class to use the properties and methods of an existing class. A class Dog could have a function named tailwagging(). If the Dog class has an object called LabradorDog, it can use the tailwagging() because it has inherited it.

### Data structures and data types (page 82)

#### Table

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
<th>Type</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integer</td>
<td>3</td>
<td>Boolean</td>
<td>TRUE</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>45.3</td>
<td></td>
<td>FALSE</td>
<td>−4.0</td>
</tr>
<tr>
<td></td>
<td>−3</td>
<td>character</td>
<td>T</td>
<td>“Well I never”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>string</td>
<td>“$%^”</td>
<td></td>
</tr>
</tbody>
</table>

2A **local** variable is only recognised in the subroutine in which it has been declared but a **global** variable is recognised throughout the program. This is known as the **lifetime** of the variable.

3

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A declaration</td>
<td>lownum is real</td>
</tr>
<tr>
<td>An array</td>
<td>numarray[999]</td>
</tr>
<tr>
<td>A loop</td>
<td>while lownum &lt;= highnum</td>
</tr>
<tr>
<td>A real variable</td>
<td>mid</td>
</tr>
<tr>
<td>A comparison</td>
<td>if X &lt;= numarray[mid] then</td>
</tr>
<tr>
<td>An assignment</td>
<td>set highnum to array length - 1</td>
</tr>
</tbody>
</table>