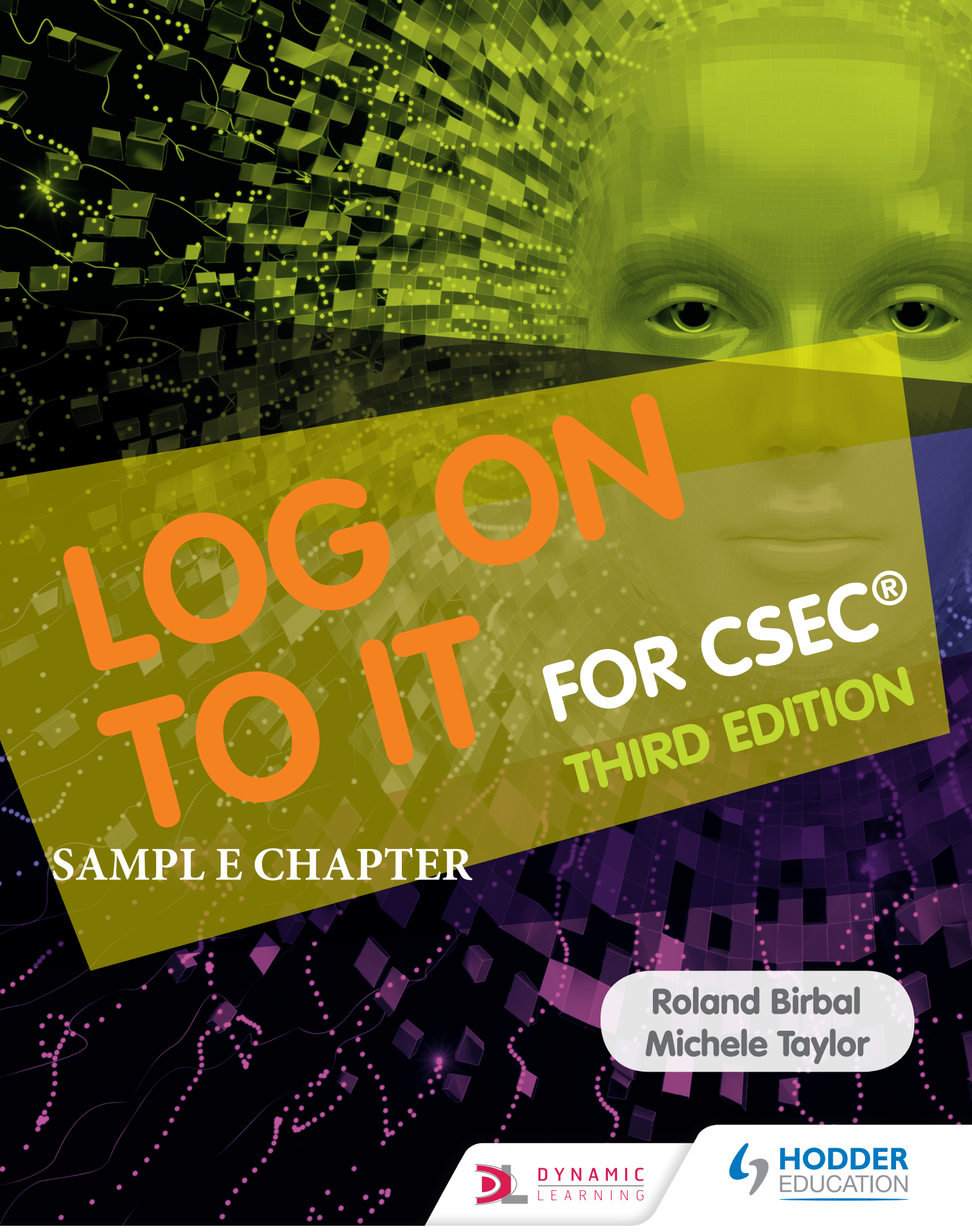

LOG ON TO IT
FOR CSEC®
THIRD EDITION
SAMPL E CHAPTER
Roland Birbal
Michele Taylor
DYNAMIC LEARNING
HODDER EDUCATION

Contents

1 Types of computers and their parts

Objectives

At the end of this chapter, you will be able to:

- define the term 'computer'
- define a computer system
- distinguish between data and information
- explain the differences between ICT, IT and computer science
- state some of the reasons for using computers
- explain the difference between hardware and software
- explain the stages involved in computer processing
- explain the functions of the central processing unit (CPU), control unit, arithmetic logic unit (ALU), registers, program counter and instruction register
- describe the different types of desktop and portable computers (laptops, notebooks, subnotebooks, netbooks, mobile phones and wearable computers)
- distinguish between the different types of computer systems: personal computers, minicomputers, mainframe computers, supercomputers, quantum computers and embedded computers
- classify computers by generations.

What is a computer?

A **computer** is a programmable electronic device. It follows a set of instructions to process data. The action of processing data produces information that can be output or stored for future use. Electronic devices use tiny electric currents, flowing through circuits, to perform their operations. Electrons form these currents, hence the term 'electron-ic'.

An example of a fairly simple computer is a calculator; it can process data and output the information from the processing. For example, adding '2 + 6' (the processing) produces '8' (the information). Other computers are much more sophisticated – as you will see later in the chapter.

A **computer system** refers to the complete computer, which includes all the hardware and software required for the computer to work. A computer system allows users to input, process, output and store data.

What is the difference between data and information?

Data is all the raw facts and figures that a computer processes by following a set of instructions called a program. Data by itself has no meaning; it can be in the form of letters (a, b, c, d ... x, y, z, and so on), numbers (1, 2, 3, 15, 456, and so on), pictures, sounds or symbols. It is only when we attach meaning to data that we get information.

For example, if you collect the temperature of your classroom each day for a month, you have collected data. When you instruct a computer to arrange (sort) this data, you could get information such as:

- the highest temperature over the period
- the lowest temperature over the period
- the mean (average) temperature over the period.

This information may then be useful, for example, to determine whether a classroom is too hot or too cold for comfortable working. If the information were just raw data, it would not be easy to interpret. Hence, the computer has helped you to look at a real-life situation or problem and make some sense of it.

▲ **Figure 1.1** Data displayed on a laptop and on a cell phone screen

What is the difference between ICT, IT and computer science?

We often confuse the terms 'information and communications technology' (ICT), 'information technology' (IT) and 'computer science', and use them interchangeably. However, these are all very different fields.

Information and communications technology (ICT) involves the use of computer hardware, software and telecommunications devices to store, manipulate, convert, protect, send and receive data. ICT has become an integral part of our daily lives and has a major impact on the way we live, work and play. The banking and finance industry relies heavily on ICT for things like customer service, fraud protection, investment, and more. Using artificial intelligence (AI) in our homes and in products such as smartphones, smart cars and video games makes our lives more comfortable. For example, many of the smart home devices such as lights, thermostats, and air-conditioning units use artificial intelligence to learn our behaviour so that they can adjust the settings themselves to make the experience match our behaviour.

Information technology (IT) deals with the study of data and data processing, and may also apply to the management of computer systems, particularly in a business setting. When used in a business, IT facilitates the business by providing four sets of core services. These core services provide information, tools to improve productivity, business process automation and a means to connect with customers.

Computer science is the study of computer hardware and software design. It includes both the study of theoretical algorithms and the practical problems involved in implementing them through computer hardware and software. The study of computer science has many branches, including AI, software engineering, programming and computer graphics.

Note

Can you think of other types of data that you can collect in your class, the computer can process to give information?

▲ **Figure 1.2** Robotic vacuum cleaners use AI technology to map their environment, by using navigational sensors.

▲ **Figure 1.3** Smart cars have a self-driving mode that combines sensors and software, to control, navigate and drive vehicles.

Why do we use computers?

The following features of modern computers assist us in our daily lives.

- **Data-processing speed:** Computers are quick; they can perform tens of millions of operations per second. With this speed comes the power to undertake many different tasks, such as predicting weather forecasts, modelling, **data crunching** and producing thousands of bills for utility companies. Data crunching refers to the analysis of large amounts of data so that it becomes useful in making decisions.
- **Data-processing accuracy:** Computers are very accurate. Errors occur only if there is an error in the way the hardware and software have been set up, or if there are errors in the data that has been input. When errors occur, it is usually because of some human error. Computers can only do what they are set up and programmed to do.
- **Ability to store large amounts of information in a small space:** There are many types of computer storage media that can be used to store large volumes of data and information. For example, a single CD-ROM disc or flash drive can hold the equivalent of a shelf of library books in electronic form.
- **Ability to work continuously:** Computers can work continuously for very long periods, only stopping for upgrading or maintenance checks. In fact, most modern computers can be left switched on all the time if desired, 24 hours per day and 7 days a week.

Hardware and software

To process data to produce information, a computer needs both hardware and software. **Hardware** is all the physical parts of the computer system you can see and touch. It is all the devices that make up the computer system. These include the internal components and the external components. The internal components are necessary for the computer to function. These include the motherboard, central processing unit (CPU), Random Access Memory (RAM) and Read Only Memory (ROM) chips, and others. The motherboard is the main printed circuit board of a computer; it allows all the parts of a computer to receive power and communicate with one another. The central processing unit (CPU) and the RAM and ROM chips are all on the motherboard. Other components or devices that run the computer or enhance its performance are either part of the motherboard or plug into it via an expansion slot or port.

▲ **Figure 1.4** Components on the motherboard of a personal computer

The external components, which are called **peripherals**, are those hardware devices that are not essential to a computer's function and are usually connected to the computer by a cable, or wirelessly. These devices include keyboards, printers, speakers, **mice** and hard drives. **Software** is a set of instructions (called a **program**) that a computer needs to carry out its tasks. For example, if you want to use the computer to type a letter, or draw a picture, or do some accounting work, you would need different types of software to accomplish these tasks. Some typical examples of software are word processors, spreadsheets, graphics packages and database packages. Both hardware and software are needed to process data.

Did you know?

Did you know that an app you download to your smartphone is software? What are some apps that you or a friend use or are familiar with?

▲ **Figure 1.5** The parts of a personal computer

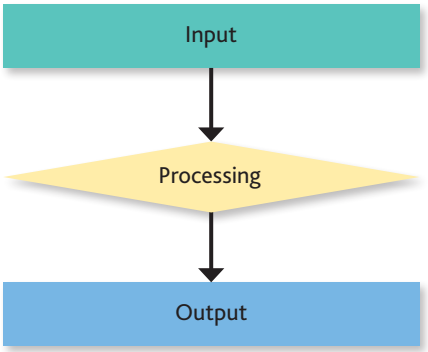
Stages of processing

To accomplish its tasks, a computer has to process data. Processing data to get information involves three stages: input, processing and output.

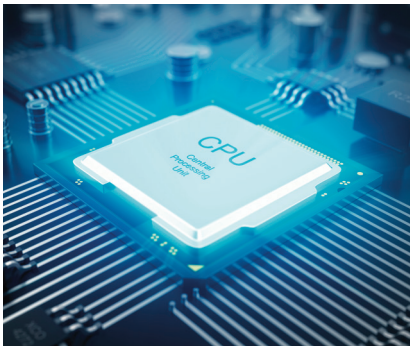
Input devices such as keyboards, joysticks, mice, touchscreens and scanners are used to get the data and instructions into the computer for processing. The processing takes place in that part of the computer called the **central processing unit (CPU)**. The CPU, also known as the **processor**, is the 'brain' of the computer. It takes raw data and follows a set of instructions (programs) to convert it into information. The CPU is made up of three components, the control unit (CU), the arithmetic logic unit (ALU) and registers. A **register** is a temporary storage location that holds a single instruction or **data item**.

Traditionally, a CPU was made up of a processor with a single core. A core contains an ALU, CU and registers. Most modern processors contain multiple cores; a processor with two cores is called a dual-core processor and a quad-core processor has four cores. They are effectively several CPUs on a single chip. The more cores a processor has, the more sets of instructions the processor can receive and process at the same time, which makes the computer faster.

The speed at which a CPU processes data to convert it to information is measured in megahertz (MHz – millions of machine cycles per second) or for newer machines, in gigahertz (GHz – billions of machine cycles per second). A **machine cycle** is the sequence of instructions performed to execute one program instruction. Computers that are used for gaming, video editing, compiling code and running intensive virtual reality require very fast processors. One of the fastest processors for personal computers at present is the Intel Core i9-7980XE. This processor is very fast because it is the first consumer desktop processor to contain 18 cores.



▲ Figure 1.6 Stages of processing



▲ Figure 1.7 A CPU

Control unit

The control unit (CU) is the main part of the CPU. It directs and coordinates all the activities within the CPU. The CU determines the sequence in which instructions are executed. It does not execute the instructions itself; instead, it sends the data and instructions to the ALU for processing. The CU is primarily responsible for the movement of data and instructions from itself to the **main memory** and ALU and back. The CU executes an instruction by performing the following steps:

1. The CU fetches the instruction from memory.
2. It decodes the instruction.
3. It fetches the data required by the instruction from memory.
4. The CU sends the data and instruction to the ALU for processing.
5. It sends the data to the memory unit after processing.

The control unit also contains a number of registers. Registers are used to store data and instructions that are needed immediately and frequently. Two examples of registers found in the control unit are the **program counter** and the **instruction register**. The program counter holds the address of the current instruction (the instruction being processed) and the instruction register holds the instruction itself.

Did you know?

The scientific unit of measure 'Hertz' (Hz) is named in honour of the German physicist Heinrich Rudolf Hertz (1857–1894). Hertz did the groundwork for the development of the vacuum tube. He also discovered electromagnetic waves.

Arithmetic logic unit

The arithmetic logic unit (ALU) performs all the arithmetic and logic functions in a computer. For example, if an instruction involves an arithmetic operation such as addition, subtraction, multiplication, division or the comparison of data, the control unit sends the data to the ALU for processing.

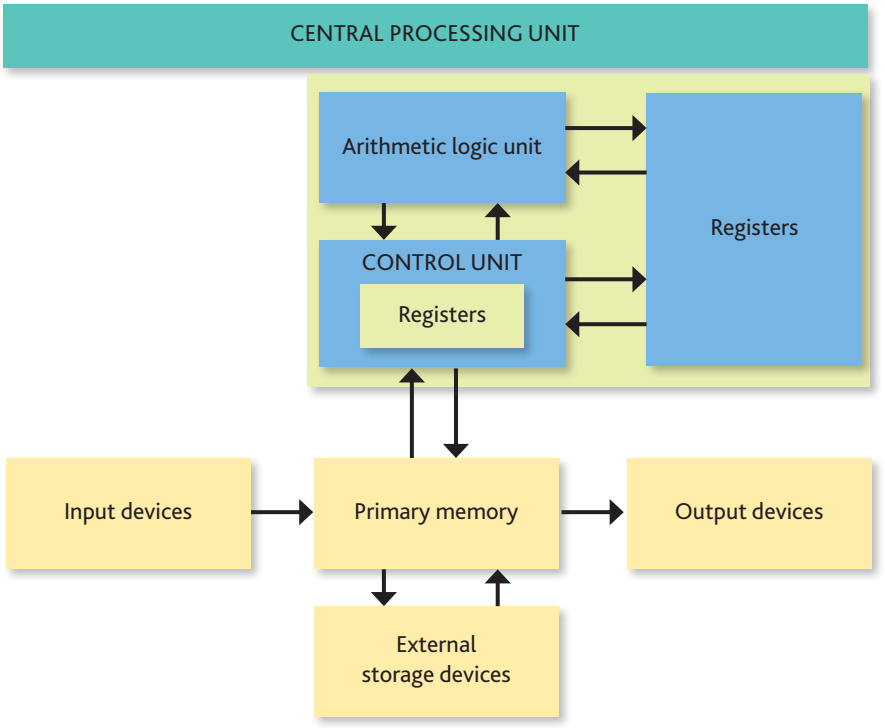
Some of the logic functions are comparisons, such as:

equal to =	not equal to ≠
less than <	greater than >
less than or equal to <=	greater than or equal to >=

For example, using the 'equal to' logic function, the ALU compares two values to determine if they are equal. Other logical operations performed by the ALU are AND, OR and NOT.

Primary memory

Primary memory, also referred to as main memory or immediate access memory, is directly accessible to the CPU and holds data and instructions that the computer is processing at the time. Therefore, the data collected in the example of the temperature of the classroom would be placed in main memory while it is being processed. Output devices then translate information processed by the computer into a form that the user can understand. After processing, the data and information can be either stored in a secondary storage device, such as a hard disk, or sent to an output device such as a printer or a computer screen.



▲ **Figure 1.8** The components of a basic computer system

Primary memory consists of two types of memory chips: Random Access Memory (RAM) and Read Only Memory (ROM). A computer uses RAM to hold data and instructions (programs) temporarily while processing is taking place. RAM also holds the data that results from processing data, which is waiting to be output or stored in a secondary storage medium. RAM is therefore also called working memory.

ROM chips hold the data and instructions necessary for starting up the computer when it is switched on. These instructions are fixed at the time of manufacture and are sometimes described as being 'hard-wired'. This ensures that the instructions stored in ROM are always there, whether the power is on or not. RAM and ROM will be discussed further in Chapter 3.

Exercise 1

1 Computers are often used because they are able to hold lots of _____ in a very small space. They can work _____ and are much better at completing many tasks because of their _____ and _____.
2 The action of _____ data produces information that can be _____ or stored for future use.
3 Two internal components that are necessary for the computer to function are _____ and _____.
4 The external components of a computer are known as _____.
5 Use the words in the list below to identify the devices that are components and those that are peripherals.

CPU	Keyboard	RAM	Mouse	Printers	Motherboard	Speakers

6 A _____ contains an ALU, control unit and registers.
7 A processor with two cores is called a _____ processor and four cores is called a _____ processor.
8 The _____ unit determines the sequence in which instructions are executed.
9 The control unit is primarily responsible for movement of data and instructions from itself to the _____ and _____ and back.
10 The _____ holds the address of the instruction being processed at the time and the instruction register holds the instruction itself.

Types of computers

Computer systems are classified on the basis of system performance, which in turn affects physical size and cost. Given the rapid pace at which computer technology is changing, classifying computers on this basis is often very difficult, since many of the newer, smaller systems can outperform the larger models of a few years ago. Nevertheless, some broad categories can be defined, as follows.

Desktop systems

A desktop computer system is designed to stay in a single location and must remain connected to a wall outlet. Although desktop systems lack portability, they offer similar or even better functionality to laptops, smartphones and other devices. Two examples of desktop systems are personal computers and gaming consoles.

Personal computers (PCs)

Personal computers (PCs), also called microcomputers, are the most common type of computer. They come in many different shapes, sizes and colours, depending on the manufacturer. PCs are used by one person at a time and fit on an office desk, hence the name 'desktop computers'. A PC consists of a system unit, a keyboard, a mouse and a display screen, and has all the functional elements found in any larger system. It performs the input, control, arithmetic and logic, output and storage functions mentioned earlier in the chapter. It can execute software program instructions to perform a very wide variety of tasks. Individuals, businesses and organisations use personal computers. The processing speed, internal memory capacity and external storage vary with the different models available. Usually, individuals or organisations will purchase a personal computer based on the purpose for which the computer will be used. The processor speed for a typical personal computer ranges from 2.4 GHz to 3.7 GHz. These computers usually have between 4 gigabyte (GB) and 32 GB of RAM and a storage capacity that varies from 40 GB to 1 terabyte (TB).

▲ **Figure 1.9** A desktop system (personal computer)

Gaming consoles

A video game console is a highly specialised desktop computer used to play video games. Gaming consoles have many of the same hardware components as computers, but are usually less advanced. This is why they cost much less than a high-end gaming computer. The player interacts with the game through a controller, which is a hand-held device with buttons and joysticks or pads. Gaming consoles are usually connected to a television, which outputs the video and sound. Examples of consoles include the Microsoft Xbox, Sony PlayStation, Nintendo GameCube, and Nintendo Wii. The processor speed for a typical gaming console ranges from 2.4 GHz to 4.1 GHz. These devices usually have between 4 GB and 32 GB of RAM and a storage capacity that varies from 512 GB to 1 TB.

▲ **Figure 1.10** A gaming console with game controllers

Mobile devices

A mobile device is a general term used to refer to devices such as laptops, tablets, smartphones and personal digital assistants (PDAs). These devices have similar characteristics such as:

- the ability to access the internet
- a battery that powers the device and can last for several hours
- a physical or onscreen keyboard for entering information
- a small size and light weight, which allows it to be carried in one hand and manipulated with the other hand
- a **touchscreen** interface in almost all cases
- wireless operation.

Did you know?

Present-day personal computers can perform tasks thousands of times faster than the personal computers of the 1980s.

Laptops

A laptop computer is a portable version of a PC, equipped with a flat liquid crystal display (LCD) screen and weighing about one to four kilograms. The two main types of laptop computers are notebooks and subnotebooks.

Notebooks

A notebook computer is a portable computer that weighs two to four kilograms and is roughly the size of a large thick notebook, around 35 × 25 × 4 centimetres. They have a fairly large LCD colour screen (about 30 cm across) and a fairly large keyboard, usually with a small touch-sensitive pad, which serves as a mouse. Notebook PCs can easily be packed into a briefcase or backpack, or simply held under your arm. They can use power from an electrical outlet or rechargeable batteries. Notebooks are usually just as powerful as a desktop PC, but cost more than their equivalent desktop PC. The processing speed and storage capacity can vary widely depending on the needs of the user. The processor speed for a typical notebook computer ranges from 2.2 GHz to 3.1 GHz. These devices usually have between 4 GB and 32 GB of RAM and a storage capacity that varies from 512 GB to 1 TB. A notebook computer is a very portable device given its relatively light weight and a battery life that varies between 9 hours and 17 hours depending on the brand.

▲ **Figure 1.11** A notebook computer

Subnotebooks

A subnotebook computer is a very portable device. It usually weighs between 1 kg and 1.5 kg, can fit in a large jacket pocket and has a battery life of more than 10 hours. It has a small screen and a small keyboard without the mouse function. It can perform many of the same functions as notebooks, but not to the same degree of complexity (difficulty). Similar to a notebook, its processing speed and storage capacity can vary widely depending on the needs of the user. The processor speed for a typical subnotebook computer ranges from 1.6 GHz to 1.8 GHz. These devices usually have between 4GB and 32 GB of RAM and a storage capacity that varies from 256 GB to 1 TB.

Netbooks

A **netbook** is a small, low-power notebook computer that weighs less than 1.5 kg and has a battery, which can provide between 6 to 12 hours of service before needing to be recharged. It has a smaller screen size (less than 30 cm), smaller keyboard size and less processing power than a full-sized laptop. It is designed to be simple and can be used to perform easy tasks like word processing, email, internet browsing, light entertainment and light productivity. They typically have less RAM and hard disk capacity than laptops. The processor speed for a typical netbook computer ranges from 1.5 GHz to 1.7 GHz. These devices usually have between 2 GB and 4 GB of RAM and a storage capacity that varies from 64 GB to 256 GB.

▲ **Figure 1.12** A netbook and wireless mouse

Tablet PCs

A tablet PC is a thin, lightweight mobile computer that typically weighs less than 1 kg and has a battery that can provide between 15 and 18 hours of battery life. It is smaller than a laptop but larger than a smartphone. All tablets use a touchscreen as their primary input device. Users can interact with the device by using their finger or a stylus. They also have the option to connect external devices such as a keyboard or mouse wirelessly.

A tablet can be used for gaming, retrieving information, keeping connected with others, shopping, entertainment or taking notes in meetings and lectures where a laptop may not be practical. A typical tablet has a processing speed of between 1.5 GHz and 2.5 GHz, 2 GB to 16 GB RAM and a storage capacity of between 256 GB and 1 TB.

▲ **Figure 1.13** A tablet PC

Smartphones

A **smartphone** is a mobile phone that performs many of the functions of a computer. It usually has a touchscreen interface, internet access, and an operating system capable of running downloaded apps. Smartphones can be used to make phone calls, surf the web, send and receive **email** messages, use a variety of apps (WhatsApp, Waze, Facebook and Uber) and play online games. The processing speed and storage capacity of smartphones varies with price. The greater the RAM, ROM and processing speed, the more expensive the smartphone. An average smartphone may have a processing speed of 2.3 GHz, 2 GB to 16 GB of RAM and a storage capacity of between 16 GB and 64 GB.

Wearable computers

The latest trend in computing is wearable computers. Essentially, common computer applications (email, database, multimedia, calendar/scheduler, health monitoring system) are integrated into watches, cell phones, visors and even clothing. For example, the Apple Watch® is a wristwatch that interfaces with the Apple iPhone® and the user can also download apps such as a calculator app, camera app, weather app and many more to the watch.

▲ **Figure 1.14** Wearable computers

Embedded computers

An embedded computer is a special-purpose computer used inside a device and is usually dedicated to specific functions. It is housed on a single printed circuit board that provides all of the circuitry necessary for a microprocessor, RAM, ROM and any necessary components. It is connected to sensors, which are devices that detect changes in the environment such as light, temperature or pressure, and actuators, which are hardware output devices that convert an electrical control signal into physical action. They are commonly used in items such as answering machines, smart televisions, washing machines, cameras, cars, motors, sewing machines, clocks and microwaves. For example, in a microwave oven, the embedded system is designed to take directions from the keypad and turn them into commands. If you program a microwave oven to operate on high for two minutes, the embedded system instructs the high-voltage transformer to operate on full discharge for two minutes. When the two minutes expire, the embedded system commands the transformer to turn off.

The processing speeds, memory and storage capacities of embedded computers are usually much lower than a typical PC computer due to the limited range of commands they are required to perform. For example, the amount of RAM required for a typical application may vary between 64 KB and 1 MB.

▲ **Figure 1.15** The button panel on a microwave

Exercise 2

True or False?

1 A desktop computer system is designed to stay in a single location.
2 Personal computers (PCs) are also sometimes called microcomputers.
3 A video game console is a highly specialised desktop computer used to play video games.
4 Notebook PCs are too large to be tucked into a briefcase or backpack.
5 A netbook computer is another name for a subnotebook computer.
6 A tablet can be used for gaming, retrieving information, keeping connected with others, shopping and entertainment.
7 The Apple Watch® is an example of a wearable computer.
8 The functions in a microwave oven are controlled by an embedded computer.
9 A modern smartphone has the same processing capacity as a modern desktop computer.
10 The processor speed for a typical netbook computer ranges from 3.5 GHz to 4.1 GHz.

Multiple-choice questions

1 Which of the following is an example of an embedded computer system?
a Notebook b Netbook
c Tablet d Smart television
2 The processing speeds of modern laptop computers can be measured in:
a gigahertz. b kilohertz.
c gigabytes. d kilobytes.
3 Information can best be described as:
a raw facts. b raw data.
c processed data. d none of the above.
4 Which of the following is best suited for taking notes in meetings and lectures?
a Desktop computer b Notebook computer
c Netbook computer d Tablet computer
5 Which of the following is not a feature of a mobile device?
a Ability to access the internet
b A battery that powers the device and can last for several hours
c A physical or onscreen keyboard for entering information
d Can only operate when plugged into a power outlet

Minicomputers

Minicomputers have become outdated and are rarely used today. They were very popular in the 1960s. Their cost and processing capabilities were somewhere between those of a PC and a mainframe computer. They were used mainly in small manufacturing plants, research labs and businesses. Mini-systems were usually designed to simultaneously (at the same time), support up to about 200 users. They allowed many users to share access to central hardware through work stations called terminals. A typical terminal has a keyboard, a display screen and a cable that connects the terminal to the computer system. Lower-capacity models have as low as 64 to 192 MB of memory, whereas higher-capacity models have as high as 1,024 to 32,768 MB of memory. Direct access storage disks are attached directly to the **server** or computer and allow a typical minicomputer to manage anywhere from 4 GB to over 18,000 GB of data.

▲ Figure 1.16 Minicomputer

Mainframes

Mainframes are very powerful computers that are very expensive. They offer more processor capacity and greater storage capacity than a typical minicomputer. A mainframe can handle thousands of users simultaneously. They are found in large organisations such as banks, government agencies, insurance companies and corporations, where they perform tasks that require a lot of computational power: typically, bulk data processing such as censuses, industry/consumer statistics and bank transaction processing. The IBM zSeries z14 Model M05 is currently one of the most powerful mainframe computers available. The IBM z14 class mainframe computer can have up to 170 processors operating at 5.2 GHz, up to 32 TB of Redundant Array of Independent Memory (RAIM) and significant amounts of storage as required.

▲ **Figure 1.17** The IBM System z14 mainframe computer

Supercomputers ('monsters')

Supercomputers such as the IBM-built Summit, and Sierra, are the world's fastest and most powerful computers in the year 2019. Supercomputers are designed to process complex scientific applications. They are typically used for 'number crunching' in scientific simulations, scientific research and developments in areas such as energy, space exploration, medicine and industry. Number crunching is the ability to perform large amounts of numerical computations quickly. Similarly, the United States Department of Energy's Oak Ridge National Laboratory (ORNL) new Summit supercomputer is providing scientists with incredible computing power to solve challenges in energy, artificial intelligence (AI), human health and other research areas that were simply out of reach until now. The Summit has 9216 processors operating at 4.0 GHz and more than 10 petabytes (PB) of total memory available, and has already set new records in AI and traditional application performance. These systems are very expensive, often costing millions of US dollars.

Did you know?

The processing power and storage capacity of the modern PC is far greater than that of a mainframe computer of the 1960s.

▲ **Figure 1.18** A supercomputer

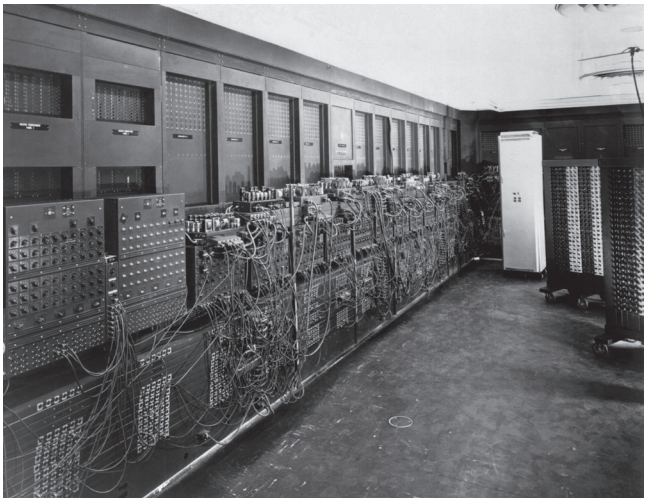
Generations of computers

Computers can be broadly classified into five generations. These generations are based mainly on the basic electronic component that was used to build the computer.

First generation (1945–1956)

The vacuum tube or valve was the main electronic component of first-generation computers. This made the computers very large; they contained many kilometres of electrical wire, used a lot of electrical power and generated a lot of heat. As vacuum tubes were blown so easily, processing was unreliable. Also, each computer had a different binary-coded program called a 'machine language' that told it how to operate, and had to be programmed directly in this machine language. This made the computer difficult to program and limited its versatility and speed.

The Harvard Mark I (electromechanical) was the first computer in this generation. The ENIAC (Electronic Numerical Integrator and Calculator), produced in 1946, was the first computer to use electrical signals for calculating and storing results with no mechanical operations involved. Other first-generation computers include UNIVAC, Burroughs 220 and the IBM 700 series.



▲ **Figure 1.19** The ENIAC computer

Second generation (1956–1963)

Transistors were invented in 1947 and these formed the basis for second-generation computers. A transistor is a device used to open and close a circuit in computer processors and digital memory. Computers became smaller, faster, more reliable and more energy-efficient than their predecessors. The machine languages of the first-generation computers were replaced by assembly language, allowing abbreviated programming codes to replace long, difficult binary codes. Some popular second-generation computers include the IBM 1400 and 1600 series, UNIVAC III, NCR 300 series and the Burroughs B500 series.

Did you know?

The transistor is considered to be one of the greatest inventions of modern times. Without transistors, modern computers would not have been possible. The transistor was invented at Bell Laboratories in December 1947 by John Bardeen, Walter Brattain and William Shockley. They were awarded the 1956 Nobel Prize in physics for their outstanding achievement.

Third generation (1964–1970)

With the invention of the integrated circuit (IC), or chip, computers became even smaller, faster, more reliable, more energy-efficient and cheaper than their predecessors. Another third-generation development was the invention and use of 'high-level' languages, which used English words and the base-10 number system to program the computer. Some third generation computers include the IBM System 3 and System 7, UNIVAC 9000 series, NCR Century series and the Burroughs 6700.

▲ **Figure 1.20** A third-generation computer

Fourth generation (1971–present)

Fouth-generation computers are still based on the chip, but with many more components packed inside. First, there was large-scale integration (LSI), where hundreds of components were placed on the chip. By the 1980s, very large-scale integration squeezed thousands of components onto a chip. Ultra-large-scale integration (ULSI) increased that number to millions of components. Computers became even smaller, cheaper and much more reliable; their processing capabilities increased accordingly. Some early examples of fourth-generation computers include the IBM System 3090 and RISC 6000, the HP 9000 and the Cray 2 XMP.

As the years have gone by, the size of a chip has decreased to the 14 nanometre (nm) size that is used in the IBM z14 today. Performance gains (improvements) now depend not only the speed of the chip, but also on the system innovation (new technological advances) adding to the complexity on the chip. The requirements that drive the complexity have also changed along the way. An example is the requirement for security in today's digital world. The IBM z14 is capable of processing over 12.5 billion fully-encrypted transactions in a day, the equivalent of 400 Cyber Mondays on a single system.

▲ **Figure 1.21** A robot is a fifth-generation computer.

Did you know?

Cyber Monday is name for the Monday after the US Thanksgiving holiday, where shops provide huge discounts to shoppers when shopping online.

Fifth generation (present–future)

Fifth-generation computers will be able to mimic many of the things that so far have only been within the capacity of human beings to achieve, namely that they will demonstrate a certain level of **artificial intelligence (AI)**. For example, fifth-generation computers, including standard PCs, are starting to accept spoken word instructions (**voice recognition**) and can now assist doctors in making very specific diagnoses (expert systems).

Computers of this generation make use of parallel processing: they are capable of performing multiple, simultaneous operations using more than one microprocessing chip. This makes them especially powerful. The eventual goal of fifth-generation computers is to develop devices that respond to natural language input and are capable of 'learning'. An AI program would eliminate the need for users to write programs, since they could communicate their orders to the computer in ordinary English.

Emerging technologies: Quantum computers

Quantum computers are designed to exploit certain properties of quantum mechanics (a physical science dealing with the behaviour of matter and energy on the scale of atoms and subatomic particles/waves) to solve problems that would be impractical or impossible for a classical (digital) computer to solve. Quantum computers work by using qubits. These qubits are not limited to values of either 1 or 0 like classical bits, but can represent both a 1 and a 0 at the same time through superposition. Qubits, when in a superposition, can be entangled; that is, a state of one qubit (either 1 or 0) can depend on the state of another. Through the use of these qubits, sophisticated switches can be made to compute certain problems that are difficult for classical computers to do.

▲ **Figure 1.22** D-Wave 2000Q™ quantum computer

Chapter 1: Summary

- Storage refers to the media and devices used to keep data and instructions for immediate or later use.
- A computer is an electronic device that processes data following a set of instructions.
- A computer system is a complete computer, which includes both hardware and software.
- Data is all the raw facts and figures that a computer processes by following a set of instructions (called a program) to produce information.
- Information and communications technology (ICT) is the use of computer hardware, software and telecommunications devices to store, manipulate, convert, protect, send and receive data.
- Information technology (IT) deals with the study of data and data processing, and may also apply to the management of computer systems, particularly in a business setting.
- Computer science is the study of computer technology (both computer hardware and software).
- We use computers for their great speed, accuracy, large storage capacity and ability to work continuously in solving a variety of problems.
- Hardware is all the parts of the computer system that you can see and touch. It consists of both the internal and external components of the computer.
- Peripherals are external hardware devices that are not essential to a computer's function and are usually connected to the computer by a cable or wirelessly. These devices include keyboards, printers, speakers, mice and hard drives.
- Software is a set of instructions (a program) that a computer needs to carry out its tasks.
- Input, processing and output are the three stages of processing.
- We use input devices to enter data and instructions into the computer for processing.
- The central processing unit (CPU) is the 'brain' of the computer. It comprises the control unit (CU), the arithmetic logic unit (ALU) and registers.
- The control unit is the main part of the CPU. It directs and coordinates all the CPU activities.
- A register is a temporary storage location that holds a single instruction or data item.
- The program counter holds the address of the current instruction (the instruction being processed) and the instruction register holds the instruction itself.
- The arithmetic logic unit (ALU) performs all the arithmetic and logic functions in a computer.
- The primary memory holds data and instructions that the computer is processing at the time.
- Primary memory consists of: Random Access Memory (RAM) and Read Only Memory (ROM) chips.
- The motherboard is the main printed circuit board of a computer that contains the CPU, and the RAM and ROM chips. It allows all the parts of a computer to receive power and communicate with one another.
- Output devices translate information that is processed by the computer into a form that the user can understand.
- We classify computer systems as personal computers, minicomputers, mainframe computers, supercomputers, quantum computers and embedded computers.
- Personal computers (PCs), also called desktop or microcomputers, are the most common computers. We design PCs to be used by one person at a time. A PC can usually fit on an office desk and consists of a system unit, a keyboard, a mouse and a display screen.
- Minicomputers have become outdated and are rarely used today. They were very popular in the 1960s. Their cost, storage and processing capabilities were between those of a PC and a mainframe computer.
- Mainframes are very powerful computers and are very expensive. They offer faster processing speeds and greater storage capacity than a typical mini.
- Supercomputers are the largest, fastest and most powerful computers at present. They are typically used for 'number crunching' in scientific simulations, scientific research and development.
- A mobile device refers to devices such as laptops, tablets, smartphones and PDAs.
- Laptops, notebooks, subnotebooks and netbooks are all portable computers with flat LCD screens.
- A tablet PC is a computer that looks like a notebook computer except that data is entered with a digitising tablet or touchscreen.
- A smartphone is a cell phone that has many of the capabilities of a computer.
- A video game console is a highly specialised desktop computer used to play video games.
- A wearable computer is an electronic device, capable of storing and processing data that is incorporated into a person's clothing or personal accessories.
- An embedded computer is used inside a device and is usually dedicated to specific functions.

Chapter 1: Questions

Fill in the blanks

1 A set of instructions that a computer needs to carry out its tasks is known as a _____.

2 _____ is a set of raw facts and figures.

3 _____ are used to get the data and instructions into the computer for processing.

4 Processing takes place in that part of the computer known as the _____.

5 _____ computers will be able to mimic many of the things that so far can only be done by human beings.

6 The _____ directs and coordinates all the activities within the CPU.

7 A(n) _____ computer is a special purpose computer that is used inside a device and is usually dedicated to specific functions.

8 A _____ is a temporary storage location that holds a single instruction or data item.

9 The _____ holds the address of the current instruction in the control unit.

10 The _____ performs all the arithmetic and logic functions in a computer.

11 The _____ holds data and instructions that the computer is processing at the time.

12 _____ translate information processed by the computer into a form that the user can understand.

True or False?

1 Data and information are the same.

2 The CPU is the main part of the computer.

3 All the data is processed in the memory unit.

4 The control unit sends data from the memory to the ALU for processing.

5 Output devices translate information processed by the computer into a form that the user can understand.

6 A modern mainframe has the same processing power as a very powerful PC.

7 An embedded computer is housed on a single microprocessor board.

8 The most popular computers today are mainframe computers.

9 A register can hold data permanently.

10 The program counter is found in the control unit.

Multiple-choice questions

1 Which of the following devices is not found in the CPU of a computer?
- a Arithmetic logic unit
- b Secondary storage
- c Control unit
- d Register

2 Where in the computer would the instructions to add two numbers be carried out?
- a Screen
- b External storage
- c CPU
- d Keyboard

3 Which of these is a function of the control unit?
- a Fetch and decode instructions from memory
- b Store data for processing
- c Perform logical operations
- d Perform arithmetic operations

4 Which of the following types of computers has the fastest processing speed?
- a Laptops
- b Mainframes
- c Embedded computers
- d Supercomputers

5 Which of the following is not an example of a peripheral device?
- a Keyboard
- b Mouse
- c RAM
- d Speakers

6 A program is a:
- a hardware device.
- b memory device.
- c set of instructions.
- d register.

7 Which device is not found in the CPU?
- a ALU
- b Control unit
- c Instruction register
- d Printer

8 The ALU processes data and stores it in:
- a the main memory.
- b the instruction register.
- c the control unit.
- d the program counter.

9 Which one of the following is not a function of the control unit?
- a Fetch instructions from memory
- b Decode instructions
- c Process instructions
- d Fetch data for required instructions

10 Complex scientific research is usually done using:
   a personal computers. b supercomputers.
   c minicomputers. d mainframe computers.

Short-answer questions

1 Define the terms 'hardware' and 'software'.

2 Using examples, explain the difference between data and information.

3 Draw a diagram showing the three stages of processing.

4 a Draw a block diagram to illustrate the main components of a computer system.
   b Describe the functions of the two main units found in the central processing unit.

5 Explain the purpose of the following devices:
   a input device. b output device.
   c main memory.

6 State FOUR reasons why we use computers.

7 Describe the features of a personal computer (PC).

8 a Explain the difference between a mainframe computer and a supercomputer.
   b State TWO reasons why a bank may want to purchase a mainframe computer.
   c Differentiate between a notebook computer and a subnotebook computer.
   d What is an embedded computer?

9 Discuss with your classmates how a portable computer could assist these professionals:
   a a teacher. b a police officer.
   c a newspaper reporter. d a sales representative.

Research questions

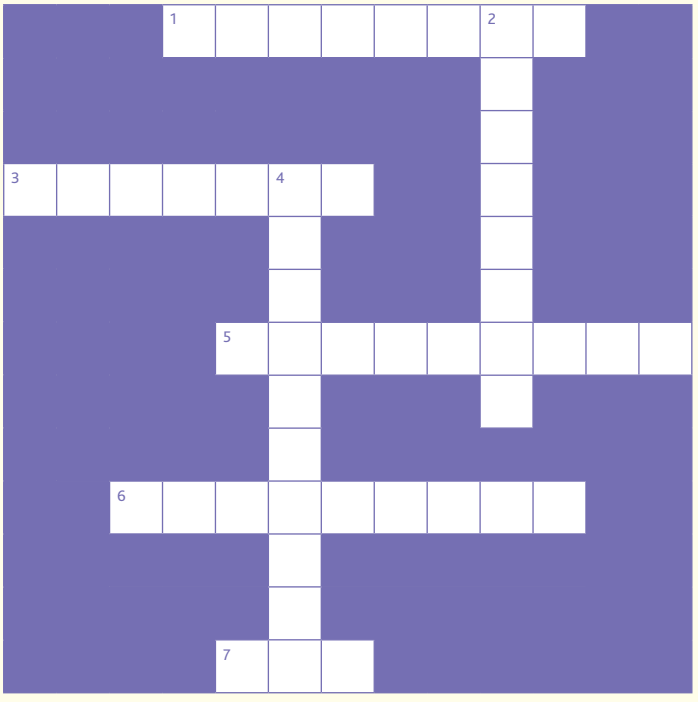
1 Your school principal wants to purchase a very fast desktop computer for the school and a laptop computer for himself. He asks you to prepare a list of the five fastest desktop computers and a list of the five fastest laptop computers. Present the information in a table with the following headings: name of computer, processing speed, manufacturer and approximate cost.

2 Using the internet to conduct your research, make a list of the top five most powerful supercomputers in the world. You are required to create a table with the name of the computer, processing speed, the purpose for which the computer is used, manufacturer and approximate cost.

3 A friend would like to buy a computer to play computer games. She would like you to provide her with a list of suggestions of the specifications for this computer, as well as three computers on the market that she can buy, which would allow her to play most of the modern computer games.

4 Use the internet to research these tasks:
   a Create a timeline to show the evolution of processors.
   b Explain how computers are used in predicting weather forecasts, modelling, data crunching and automation.

Crossword



Across

1 A device in the control unit that is used to store data and instructions that are needed immediately and frequently (8)

3 A set of instructions that the computer needs to carry out a task (7)

5 It represents billions of machine cycles per second (9)

6 Also known as the brain of the computer (9)

7 Performs the logic functions in the computer (3)

Down

2 A special-purpose computer used inside a device (8)

4 A type of intelligence that will be used in fifth-generation computers (10)

Benefit from expert guidance in this new edition of a tried and trusted approach; updated to reflect the new CSEC® IT curriculum, it provides an engaging and accessible approach to theory and practice.

- Prepare for SBA with advice and guidance and a full sample SBA project and suggested solution at the end of Chapter 16.
- Consolidate learning through a range of question types such as Multiple Choice, True or False, Short Answer, Research, Project and a fun Crossword puzzle.
- Confidently cover new topics and emerging technology with straightforward explanations and numerous examples.
- The answers can be found here: www.hoddereducation.co.uk/Log-on-to-IT-Answers

Roland Birbal is an Assistant Professor in Educational Technology and Instructional Design at the University of Trinidad and Tobago. He is also a former IT examiner and highly experienced teacher.

Michele Taylor is an IT lecturer at the School of Education, UWI, St Augustine, Trinidad and Tobago and is currently pursuing her doctorate. She is also a highly experienced IT and Computer Literacy secondary school teacher, pan-Caribbean curriculum writer and examiner.

HODDER EDUCATION
e: education@bookpoint.co.uk
w: hoddereducation.com

ISBN 978-1-5104-5998-4

FSC