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ICT

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Chapter 01

Types and components of computer systems

1.1 Hardware and software

1.1.1 Hardware

Hardware is the general term for the physical components that make up a typical computer system.

» keyboard
» mouse   } input device
» camera
» monitor
» printer   } output device
» plotter

Hardware falls into two categories: internal and external. The list above are examples of external hardware, which is discussed in detail in Chapter 2. Figure 1.1 considers the following internal hardware devices:

» Motherboard
» Central processing unit (CPU)/processor
» Random access memory (RAM)
» read-only memory (ROM)
» Graphics card
» Sound card
» Network interface card (NIC)
» Internal storage devices (hard disk drive and solid-state drive).

Motherboard: RAM:

ROM: Graphics card:
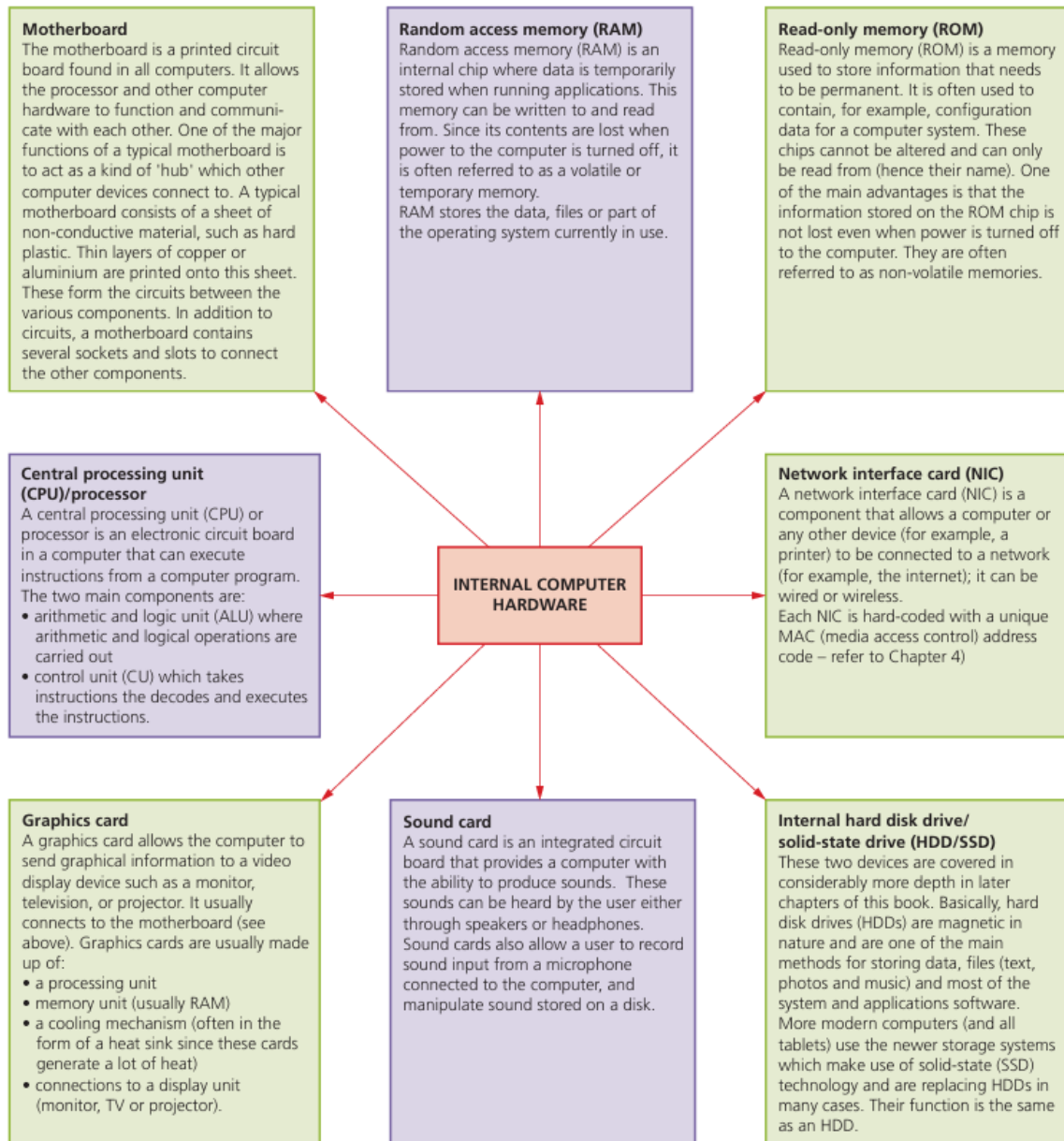
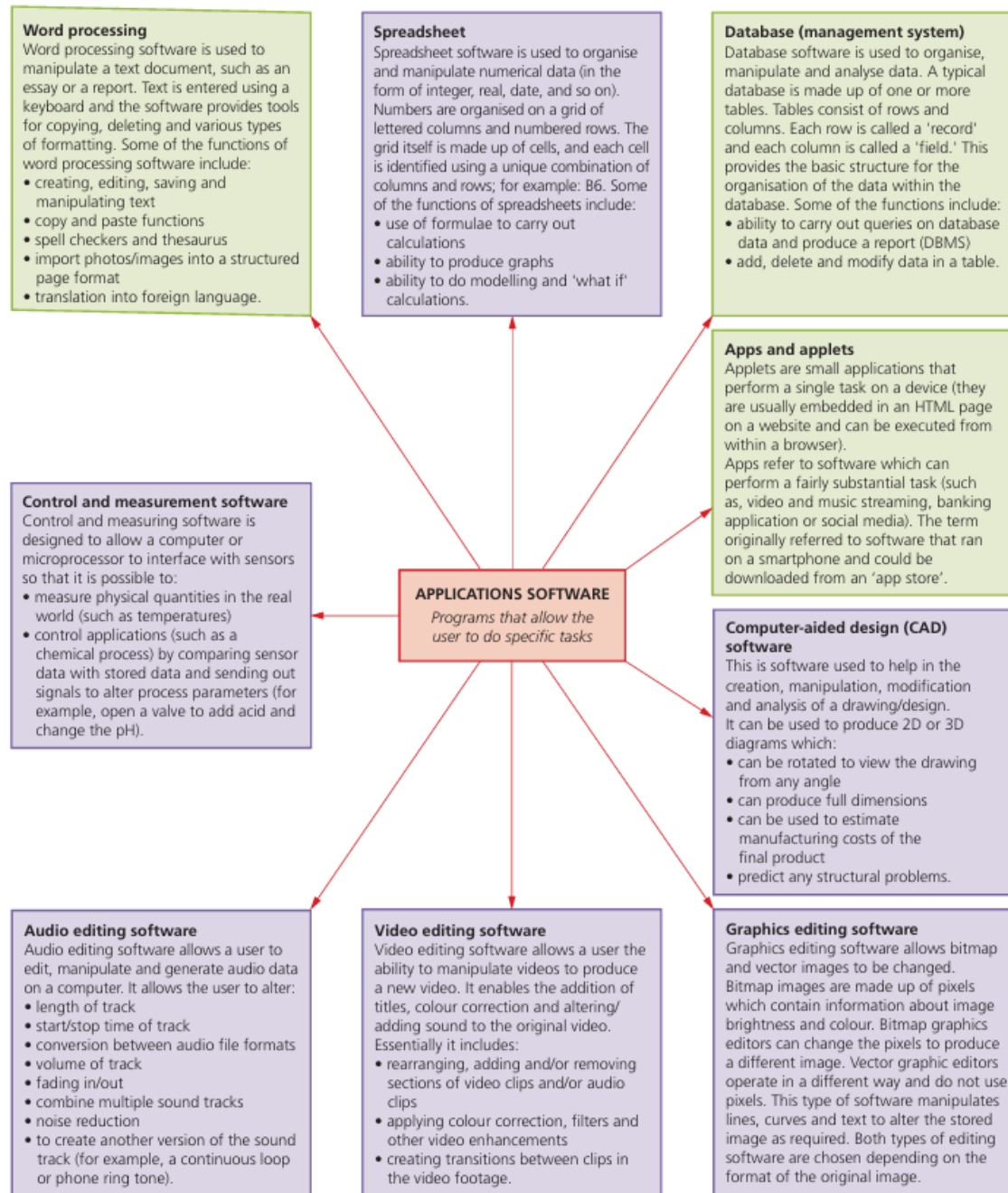Sound card: SSD:
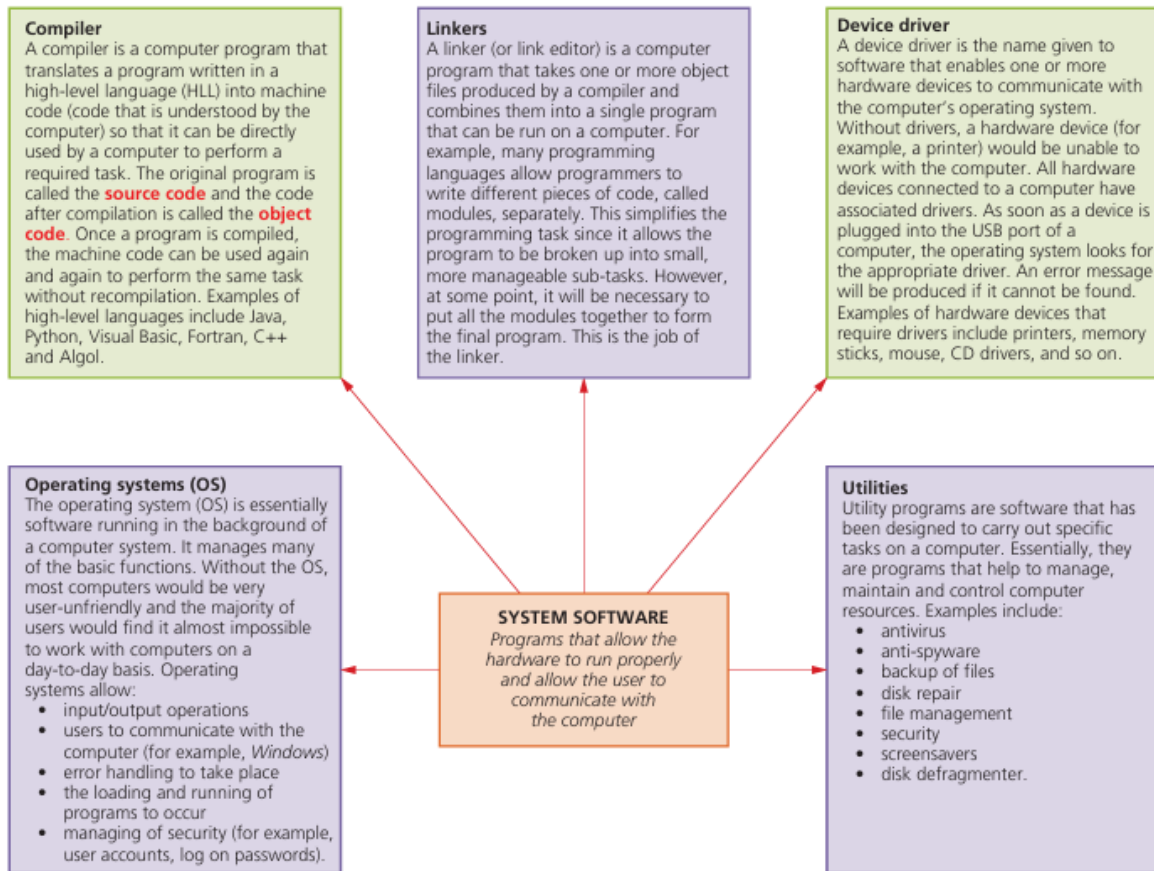
HDD:

▲ **Figure 1.2** Examples of internal hardware

Motherboard
The motherboard is a printed circuit board found in all computers. It allows the processor and other computer hardware to function and communicate with each other. One of the major functions of a typical motherboard is to act as a kind of 'hub' which other computer devices connect to. A typical motherboard consists of a sheet of non-conductive material, such as hard plastic. Thin layers of copper or aluminium are printed onto this sheet. These form the circuits between the various components. In addition to circuits, a motherboard contains several sockets and slots to connect the other components.

Random access memory (RAM)
Random access memory (RAM) is an internal chip where data is temporarily stored when running applications. This memory can be written to and read from. Since its contents are lost when power to the computer is turned off, it is often referred to as a volatile or temporary memory.
RAM stores the data, files or part of the operating system currently in use.

Read-only memory (ROM)
Read-only memory (ROM) is a memory used to store information that needs to be permanent. It is often used to contain, for example, configuration data for a computer system. These chips cannot be altered and can only be read from (hence their name). One of the main advantages is that the information stored on the ROM chip is not lost even when power is turned off to the computer. They are often referred to as non-volatile memories.

Central processing unit (CPU)/processor
A central processing unit (CPU) or processor is an electronic circuit board in a computer that can execute instructions from a computer program. The two main components are:
• arithmetic and logic unit (ALU) where arithmetic and logical operations are carried out
• control unit (CU) which takes instructions the decodes and executes the instructions.

INTERNAL COMPUTER HARDWARE

Network interface card (NIC)
A network interface card (NIC) is a component that allows a computer or any other device (for example, a printer) to be connected to a network (for example, the internet); it can be wired or wireless.
Each NIC is hard-coded with a unique MAC (media access control) address code – refer to Chapter 4)

Graphics card
A graphics card allows the computer to send graphical information to a video display device such as a monitor, television, or projector. It usually connects to the motherboard (see above). Graphics cards are usually made up of:
• a processing unit
• memory unit (usually RAM)
• a cooling mechanism (often in the form of a heat sink since these cards generate a lot of heat)
• connections to a display unit (monitor, TV or projector).

Sound card
A sound card is an integrated circuit board that provides a computer with the ability to produce sounds. These sounds can be heard by the user either through speakers or headphones. Sound cards also allow a user to record sound input from a microphone connected to the computer, and manipulate sound stored on a disk.

Internal hard disk drive/ solid-state drive (HDD/SSD)
These two devices are covered in considerably more depth in later chapters of this book. Basically, hard disk drives (HDDs) are magnetic in nature and are one of the main methods for storing data, files (text, photos and music) and most of the system and applications software. More modern computers (and all tablets) use the newer storage systems which make use of solid-state (SSD) technology and are replacing HDDs in many cases. Their function is the same as an HDD.

▲ **Figure 1.1** Internal computer hardware

1.1.2 Software

Software is the general term used for the programs that control the computer system and process data. The software considered in this book falls into two categories: applications and system.

Applications software provides the services that the user requires to solve a given task.

**System software** is the software designed to provide a platform on which all other software can run.

Word processing
Word processing software is used to manipulate a text document, such as an essay or a report. Text is entered using a keyboard and the software provides tools for copying, deleting and various types of formatting. Some of the functions of word processing software include:
• creating, editing, saving and manipulating text
• copy and paste functions
• spell checkers and thesaurus
• import photos/images into a structured page format
• translation into foreign language.

Spreadsheet
Spreadsheet software is used to organise and manipulate numerical data (in the form of integer, real, date, and so on). Numbers are organised on a grid of lettered columns and numbered rows. The grid itself is made up of cells, and each cell is identified using a unique combination of columns and rows; for example: B6. Some of the functions of spreadsheets include:
• use of formulae to carry out calculations
• ability to produce graphs
• ability to do modelling and 'what if' calculations.

Database (management system)
Database software is used to organise, manipulate and analyse data. A typical database is made up of one or more tables. Tables consist of rows and columns. Each row is called a 'record' and each column is called a 'field.' This provides the basic structure for the organisation of the data within the database. Some of the functions include:
• ability to carry out queries on database data and produce a report (DBMS)
• add, delete and modify data in a table.

Apps and applets
Applets are small applications that perform a single task on a device (they are usually embedded in an HTML page on a website and can be executed from within a browser).
Apps refer to software which can perform a fairly substantial task (such as, video and music streaming, banking application or social media). The term originally referred to software that ran on a smartphone and could be downloaded from an 'app store'.

Control and measurement software
Control and measuring software is designed to allow a computer or microprocessor to interface with sensors so that it is possible to:
• measure physical quantities in the real world (such as temperatures)
• control applications (such as a chemical process) by comparing sensor data with stored data and sending out signals to alter process parameters (for example, open a valve to add acid and change the pH).

APPLICATIONS SOFTWARE
Programs that allow the user to do specific tasks

Computer-aided design (CAD) software
This is software used to help in the creation, manipulation, modification and analysis of a drawing/design. It can be used to produce 2D or 3D diagrams which:
• can be rotated to view the drawing from any angle
• can produce full dimensions
• can be used to estimate manufacturing costs of the final product
• predict any structural problems.

Audio editing software
Audio editing software allows a user to edit, manipulate and generate audio data on a computer. It allows the user to alter:
• length of track
• start/stop time of track
• conversion between audio file formats
• volume of track
• fading in/out
• combine multiple sound tracks
• noise reduction
• to create another version of the sound track (for example, a continuous loop or phone ring tone).

Video editing software
Video editing software allows a user the ability to manipulate videos to produce a new video. It enables the addition of titles, colour correction and altering/adding sound to the original video. Essentially it includes:
• rearranging, adding and/or removing sections of video clips and/or audio clips
• applying colour correction, filters and other video enhancements
• creating transitions between clips in the video footage.

Graphics editing software
Graphics editing software allows bitmap and vector images to be changed. Bitmap images are made up of pixels which contain information about image brightness and colour. Bitmap graphics editors can change the pixels to produce a different image. Vector graphic editors operate in a different way and do not use pixels. This type of software manipulates lines, curves and text to alter the stored image as required. Both types of editing software are chosen depending on the format of the original image.

▲ **Figure 1.3** Applications software

Compiler
A compiler is a computer program that translates a program written in a high-level language (HLL) into machine code (code that is understood by the computer) so that it can be directly used by a computer to perform a required task. The original program is called the **source code** and the code after compilation is called the **object code**. Once a program is compiled, the machine code can be used again and again to perform the same task without recompilation. Examples of high-level languages include Java, Python, Visual Basic, Fortran, C++ and Algol.

Linkers
A linker (or link editor) is a computer program that takes one or more object files produced by a compiler and combines them into a single program that can be run on a computer. For example, many programming languages allow programmers to write different pieces of code, called modules, separately. This simplifies the programming task since it allows the program to be broken up into small, more manageable sub-tasks. However, at some point, it will be necessary to put all the modules together to form the final program. This is the job of the linker.

Device driver
A device driver is the name given to software that enables one or more hardware devices to communicate with the computer's operating system. Without drivers, a hardware device (for example, a printer) would be unable to work with the computer. All hardware devices connected to a computer have associated drivers. As soon as a device is plugged into the USB port of a computer, the operating system looks for the appropriate driver. An error message will be produced if it cannot be found. Examples of hardware devices that require drivers include printers, memory sticks, mouse, CD drivers, and so on.

Operating systems (OS)
The operating system (OS) is essentially software running in the background of a computer system. It manages many of the basic functions. Without the OS, most computers would be very user-unfriendly and the majority of users would find it almost impossible to work with computers on a day-to-day basis. Operating systems allow:
- input/output operations
- users to communicate with the computer (for example, *Windows*)
- error handling to take place
- the loading and running of programs to occur
- managing of security (for example, user accounts, log on passwords).

SYSTEM SOFTWARE
Programs that allow the hardware to run properly and allow the user to communicate with the computer

Utilities
Utility programs are software that has been designed to carry out specific tasks on a computer. Essentially, they are programs that help to manage, maintain and control computer resources. Examples include:
- antivirus
- anti-spyware
- backup of files
- disk repair
- file management
- security
- screensavers
- disk defragmenter.

▲ **Figure 1.4** System software

1.1.3 Analogue and digital data

Computers can only understand data which is in a binary format (that is, a base 2 number system where only the values 0 and 1 can be used). This is often referred to as **digital data** (because it can only have discrete, discontinuous values). However, data in the real world is **analogue** in nature.
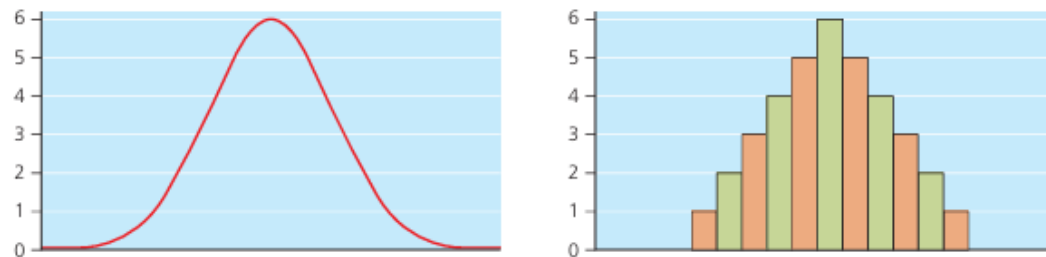
▲ **Figure 1.5** Analogue and digital data

The graph on the right displays **only** the **exact** values of 0, 1, 2, 3, 4, 5, or 6 from the analogue data, indicating a smooth curve.

If analogue data is being sent to a computer, it must first be converted into digital data; this is done by hardware known as an **analogue to digital converter** (ADC). If the computer is controlling a device (such as a motor) then the digital output from the computer needs to be converted into analogue form. This is done by a **digital to analogue converter (DAC).**

1.2 Main components of computer systems

As already mentioned in Section 1.1, a typical computer system is made up of hardware and software.

▼ **Table 1.1** Examples of input, output and secondary storage devices

Device	Examples
Input devices	keyboard, mouse, camera, microphone, sensor, scanner
Output devices	monitor, printer, speakers, projector, (graph) plotter
Secondary storage devices	hard disk drive, solid-state drive, pen drive

The internal hardware devices were shown in Figure 1.2 – these consist of four key components:
» The central processing unit (CPU) (contained on the motherboard)
» Internal hard disk drive or solid-state drive » random access memory (RAM)
» Read-only memory (ROM).

1.2.1 CPU

The **central processing unit (CPU)** is the part of the computer that interprets and executes the commands from the computer hardware and software. It is normally part of the computer motherboard.
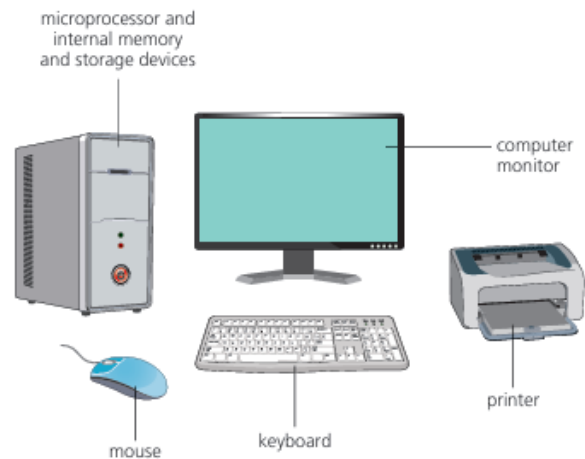
▲ **Figure 1.6** A typical computer system

CPUs used to be made up of discrete components and numerous small integrated circuits; these were combined on one or more circuit board(s). However, due to modern manufacturing techniques, the CPU is now referred to as a **microprocessor**.

1.2.2 Internal memory

Random access memory (RAM) is an internal chip where data is temporarily stored when running applications. This memory can be written to and read from.

Read-only memory (ROM) is a memory used to store information that needs to be permanent. It is often used to contain, for example, configuration data for a computer system. Chips used for ROM cannot be altered and can only be read from (hence their name).

It is worth noting that that ROM also contains some coding known as the **boot file**. This code tells the computer what to do when it first starts up; it is often referred to as the **BIOS (basic input/output system).**

When the computer is turned on, the BIOS carries out a hardware check to find out if all the devices are present and whether they are functional. Then it loads the **operating system** into the RAM.

The BIOS stores the date, time and system configuration in a non-volatile chip called **a CMOS (complementary metal oxide semiconductor)** – this is usually battery powered.

Table 1.2 provides a summary of the main differences between RAM and ROM.

▼ Table 1.2 RAM and ROM differences

RAM	ROM
Temporary memory device	Permanent memory device
Volatile memory	Non-volatile memory device
Can be written to and read from	Read-only, data stored cannot be altered
Used to store data, files, programs, part of operating systems (OS) currently in use	Used to store BIOS and other data needed at start up
Can be increased in size to improve operational speed of a computer	

1.2.3 Input and output devices

Input devices are hardware that convert data into a computer-readable form using manual or direct data entry methods. They can be keyboards, mice, sensors, or optical character readers. When a computer processes data, it sends the data to an output device, which displays the results in a human-readable form. Some devices can act as both input and output, but most are limited to either.

1.2.4 Backing storage

The main memories in a computer are RAM and ROM. However, to permanently store large amounts of data it is necessary to use backing storage. This normally takes the form of the **internal hard disk drive (HDD)** or **solid-state drive (SSD).**

▼ Table 1.3 Comparison of input and output devices

Input devices	Output devices
An input device is any hardware device that allows a user to enter data or instructions into a computer directly.	An output device is any hardware device that takes the output data from a computer and puts it into a human-readable format or uses it to control another device.
An input device can send data to another device, but it cannot receive data from another device.	An output device is capable of receiving data from another device in order to generate an output, but it cannot send data to another device.
Input devices are necessary for a computer to receive commands from its users and data to process; the devices are under the control of the user or can be direct data entry.	Output devices are needed by a computer so it can share the results of its processing with a human; output devices are under the control of the computer.
Input devices can be fairly complicated because they have to ensure that the user can interact with the computer correctly.	Output devices are less complex than input devices because they only have to turn computer signals into an output.

▼ Table 1.4 Comparison of internal memory and backing storage

Internal memory	Backing storage
RAM contents are lost when computer is powered down; ROM contents are readable only.	Backing storage devices hold their contents permanently, even when powered down.
RAM and ROM are much smaller memories than backing storage.	Have considerably larger capacity to store data than RAM or ROM.
Data access time on RAM and ROM is extremely fast.	Has much slower data access time than RAM and ROM.
Much more expensive per byte than backing storage devices.	Is much cheaper per byte than RAM or ROM.
RAM and ROM are fixed inside the computer (internal memories).	Backing storage can either be fixed (external or internal) or it can be removable.
RAM and ROM can be read directly by the CPU.	Before data on a backing storage device can be read by the CPU, it must first be moved into RAM; this means backing storage is not directly addressable by the CPU.

1.3 Operating systems

To enable computer systems to function and to allow users to communicate with computer systems, special software, known as **operating systems (OS),** have been developed. The general tasks for a typical operating system include:

» Control of the operation of the input, output and backing storage devices
» Supervising the loading, running and storage of applications programs
» Dealing with errors that occur in application programs
» Maintaining security of the whole computer system
» Maintaining a computer log (which details computer usage)
» Allowing communication between user and the computer system (user interface)

1.3.1 User interfaces

Operating systems offer various types of user interface. We will consider four different types:
» Command line interface (CLI)
» Graphical user interface (GUI)
» Dialogue-based user interface
» Gesture-based user interface.

Command line interface (CLI)

A command line interface (CLI) requires a user to type in instructions to choose options from menus, open software, etc.
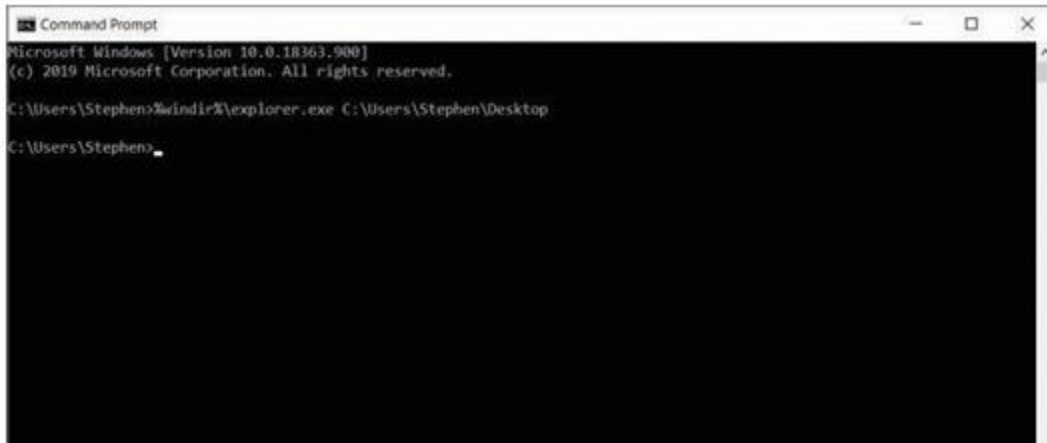
▲ **Figure 1.7** Sample of CLI code

Graphical user interface (GUI)

A **graphical user interface (GUI)** allows the user to interact with a computer (or MP3 player, gaming device, mobile phone, etc.) using pictures or symbols (**icons**) rather than having to type in several commands.

GUIs use various technologies and devices to provide the user interface. One of the most common is **WIMP (windows icons menu and pointing device)** which was developed for use on personal computers (PC).
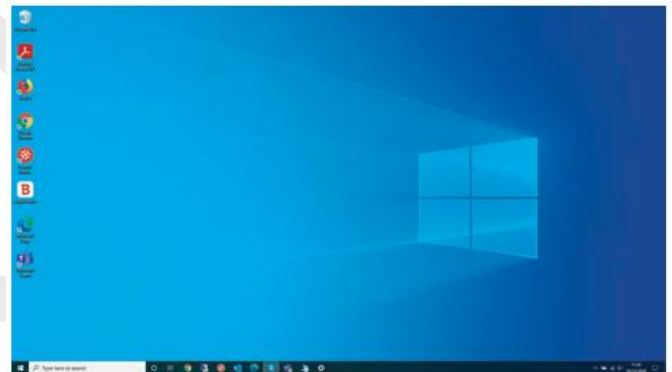
▲ **Figure 1.8** Screen image showing icons

In recent years, devices such as **touch screen** smartphones and tablets use **post - WIMP** interaction, where fingers are in contact with the screen allowing actions, such as **pinching** and **rotating**, which would be difficult to do using a single pointer and device such as a mouse.

▼ **Table 1.5** Advantages and disadvantages of CLI and GUI interfaces

Interface	Advantages	Disadvantages
Command line interface (CLI)	The user is in direct communication with the computer. The user is not restricted to a number of pre-determined options. It is possible to alter computer configuration settings.	The user needs to learn a number of commands to carry out basic operations. All commands need to be typed in, which takes time and can be error-prone. Each command must be typed in using the correct format, spelling, and so on.
Graphical user interface (GUI)	The user does not need to learn any commands. It is more user-friendly; icons are used to represent applications. A pointing device (such as a mouse) is used to click on an icon to launch the application – this is simpler than typing in commands.	This type of interface uses up considerably more computer memory than a CLI interface. The user is limited to the icons provided on the screen. Needs a more complex operating system, such as *Windows*, to operate, which can be slower to execute commands.

Who would use each type of interface?

CLI: a programmer, analyst or technician; basically, somebody who needs to have direct communication with a computer to develop new software, locate errors and remove them, initiate memory dumps (contents of the computer memory at some moment in time), and so on.

GUI: the end-user who does not have to (or does not need to) have any great knowledge of how the computer works; a person who uses the computer to run software, play games or store/manipulate photographs, for example.

Dialogue-based user interfaces

Dialogue-based user interfaces use the human voice to give commands to a computer system. An example of its use is in some luxury modern cars, where voice activation is used to control devices such as the in-car entertainment system or satellite navigation system. By speaking certain commends, such as 'Hey BMW, drive me to the nearest airport', the system allows natural speech to enable the driver to intuitively interact with the car.
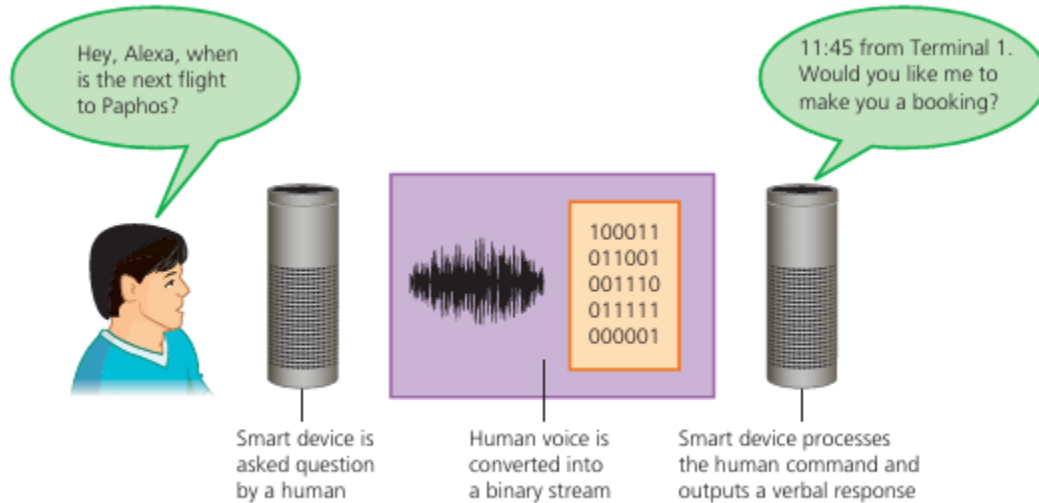
Figure 1.9 Smart voice activated devices

Gesture-based interfaces

Gesture-based interfaces rely on human interaction by the moving of hands, head or even the feet. Gesture recognition allows humans to interface with a computer in a more natural fashion without the need for any mechanical devices. This type of interface uses techniques known as **computer vision** and **image processing**.

The following gestures can be used to carry out certain functions:

» Rotating a finger clockwise near the radio will increase the sound volume (rotating the finger anti-clockwise will reduce the sound volume)

» Opening the thumb and next finger will change the track being listened to (for example, in a playlist)

» Moving the foot under the rear bumper of the car automatically opens the boot lid

» Moving a hand near a window switch automatically opens a window.

▼ **Table 1.6** Advantages and disadvantages of dialogue-based and gesture-based interfaces

Interface	Advantages	Disadvantages
Dialogue-based interface	» no need for a driver to take their hands off the steering wheel » in a home, very useful for people with disabilities, because many tasks can be carried out by the spoken word only » possible to use as a security feature, because voice recognition could be used to identify a person	» still unreliable, with many commands not being recognised or needing to be repeated several times (especially if there is background noise) » can be quite complex to set up » user needs to know which commands can be used
Gesture-based interface	» replaces mechanical input devices » no physical contact required » very natural interface for a human operator » no training needed to interface with the computer	» possible for unintentional movement to be picked up » only works fairly near to the camera or sensor (maximum of 1.5 metres) » may only accept a limited number of movements (for example, it may take several attempts to find out exactly what finger movements are recognised)

1.4 Types of computers

There are many types of computer systems in existence. The following summarises some of the more common types currently available:

1.4.1 Desktop computers

Desktop usually refers to a general-purpose computer that is made up of separate monitor, keyboard, mouse and processor unit.

The advantages of desktop computers over laptop computers are:

» Spare parts and connections tend to be standardised, which usually results in lower costs.

» Desktop computers are easier, and less expensive, to upgrade or expand.

» The desktop tends to have a better specification (for example, faster processor) for a given price (often due to size and construction constraints in l aptops).

» Power consumption is not critical because they usually plug straight into a wall socket, and the larger casings allow a better dissipation of any heat build-up.

» Because they are usually fixed in one location, there is less likelihood of them being damaged or stolen.

» Internet access can be more stable because a desktop computer is more likely to have a wired internet connection

They do have disadvantages when compared to laptop computers:

» The most obvious is that they are not particularly portable because they are made up of separate components.

» They tend to be more complicated because all the components need to be hooked up by wiring, which also clutters up the desk space.

» Because they are not particularly portable, it is necessary to copy files on,

The main uses of desktop computers include:

» Office and business work (word processing, spreadsheets, finance software and databases being the main use)

» Educational use (using interactive software to teach or learn from)

» Use as a gaming device (for example, games such as chess, crossword puzzles, fantasy games, and so on)

» General entertainment (for example, live or 'catch-up' streaming of television programmes).

1.4.2 Mobile computers

Mobile computers, by their very name, suggest a group of computers which are considerably more portable than desktop computers. Such computers fall into four categories:

» Laptop computers
» Smartphones
» Tablets
» Phablets.

Laptop (or notebook)

Laptop (or notebook) refers to a type of computer where the monitor, keyboard, pointing device and processor are all together in one single unit. This makes them extremely portable.

Key features you would expect to find in a laptop:
» Lightweight (to aid portability)
» Low power consumption (and also long battery life)
» Low heat output (cooling is very important).

Laptop computers do have advantages when compared to desktop computers:

» The most obvious advantage is their portability;

» Because everything is in one single unit, there are no trailing wires (only one single cord is used).

» They take up much less room on a desk, so they can be used anywhere (for example, in a café).

» Their portability allows them to take full advantage of Wi-Fi features.

» Because they are portable, they can link into any multimedia system.

Laptop computers also have disadvantages when compared to desktop computers:

» Because they are easily portable, they are also easier to steal!

» They have limited battery life so the user may need to carry a heavy power adaptor.

» The keyboards and pointing devices can sometimes be more awkward to use.

» It is not always possible to upgrade them, for instance by adding more RAM.

The main uses of laptop computers include:

» Office and business work (word processing, spreadsheets, finance software and databases being the main use)
» Educational use (using interactive software to teach or learn from)
» Used as a gaming device
» General entertainment
» Used in control and monitoring

Smartphones

Smartphones allow normal phone calls to be made, but also have an operating system (such as iOS, Android or Windows) allowing them to run several computer applications (known as apps or applets). They allow users to send/receive emails, use several apps, use a camera feature (to take photos or videos), MP3/4 players (for music and videos), and so on.

Some of the typical features of smartphones include:
» High-definition, anti-glare displays
» Front- and back-facing cameras
» Lower weight and longer battery life than laptops
» Use Bluetooth for connection to printers and other devices
» Make use of flash (solid state) memory and cloud storage facilities to back up and synchronise
» They use several sensors to carry out the following functions:

– Proximity sensors to detect if the device is close to,
– Accelerometers, which detect movement and orientation of the device
– Can use sophisticated speech recognitions systems (such as Siri) to enable the user to ask the device to look for things (such as search the address book).

Advantages of smartphones:

» They are very small in size and lightweight – therefore they are very easy to always carry and have on your person

» You can use them to make phone calls, but also connect to the internet while on the move.

» Because they use Wi-Fi and mobile phone networks they can be used almost anywhere

» They have apps which make use of sensor data provided by the smartphone, for instance location data for maps – this can provide services that are not available on desktops or laptops.

» They have a reasonable battery life compared to laptops.

Disadvantages of smartphones:

» The small screens and keyboards make pages difficult to read.

» It is more difficult and slower when typing things in

» Web browsing and photography can quickly drain the battery.

» Memory size in most phones is not very large when compared to laptops and desktops – although it is comparable with tablets

» Not all website features are compatible with smartphone operating systems.

» Because of their small size, it is much easier to lose a smartphone or for it to be stolen compared to laptops or desktops.

» The data transfer rate using mobile phone networks can be slower than with Wi-Fi – this makes streaming of video or music, for example, less than satisfactory at times.

Tablets

Tablets are becoming an increasingly used type of mobile computer. They work in a similar way to a smartphone. Tablets use touch screen technology and do not have a conventional keyboard. The keyboard is **virtual**; that is, it is part of the touch screen and keys are activated by simply touching them with a finger or a stylus.

Advantages of tablets compared to laptops:

» Very fast to switch on (no time delay waiting for the operating system to load up)
» Fully portable – they are so lightweight that they can be carried anywhere
» Touch screen technology means they are simple to use and do not need any other input devices
» Can use several apps as standard (such as built-in camera, MP3/4 players and so on)
» Not much heat – they use solid-state technology
» Battery life of a tablet is a lot longer
» When the power button is pressed, it goes into standby, but remains connected to the internet so the user still hears alerts when emails or other 'events' are received.

Disadvantages of tablets compared to laptops:

» Tend to be rather expensive when compared to laptops
» They often have limited memory or storage when compared to a laptop (although some of the latest devices have 1 TiB memory capacity)
» If 3G/4G/5G mobile phone networks are used, they can be expensive to run if the internet is being accessed frequently
» Typing on a touch screen can be slow and error-prone compared to a standard keyboard
» Transferring of files often has to be done through an 'application atore'; this lack of 'drag and drop' facility can prove to be irritating to users
» Laptops tend to support more types of file format than tablets and are also better equipped to run different types of software.

Some of the latest smartphones have been designed as a hybrid between a tablet and a smartphone; these are referred to as a **phablet**.

| Smartphones | Phablets | Tablets |
| up to 5.1 inches in size (that is, 13 cm) | between 5.1 inches and 7 inches (that is, 13 cm to 18 cm) | over 7 inches in size (that is, over 18 cm) |

▲ **Figure 1.14** Comparison of smartphone, phablet and tablet

The main uses of smartphones, tablets and phablets include:

» Entertainment (streaming of music, videos and television programmes)

» Gaming (including group games)

» As a camera or video camera (the quality of videos and photos now matches a good digital cameras)

» Internet use (online sales, social networks, using QR codes, and so on)

» sending/receiving emails

» Global positioning system (use of maps to navigate to a location)

» Calendar functions » telephone banking (sending and receiving money using the banking apps)

» Voice over Internet Protocol (VoIP) – telephone network using the internet which also allows video calling

» Instant access to social networks (social contact with friends no matter where you are in the world)

» Instant messaging

» Office and business management (particularly the features that allow rapid voice and video communication)

» Education use (using interactive software to teach or learn from)

» Remotely control devices

1.5 Emerging technologies

1.5.1 Impact of emerging technologies

Artificial intelligence

There are many definitions of **artificial intelligence (AI).** Essentially, AI is a machine or application which carries out a task that requires some degree of intelligence.

The impact of AI on everyday life

Whenever AI is mentioned, people usually think of science fiction fantasies and think of **robots**. The science fiction writer Isaac Asimov even went as far as producing his three laws of robotics:

» Robots may not injure a human through action or inaction
» Robots must obey order given by humans without question
» A robot must protect itself unless it conflicts with the two laws above.

▲ **Figure 1.15** An autonomous (driverless) vehicle – we already have driverless trains and autopilots on aeroplanes, but future developments include driverless cars.

▲ **Figure 1.16** Robotic research is leading to improvements in technology to help amputees and people with disabilities.

▲ **Figure 1.17** Robots are used to help people carry out dangerous or unpleasant tasks – for example, bomb disposal, welding of car bodies, entering nuclear disaster areas (such as Chernobyl or Fukushima) where the radiation would kill a human in under two minutes.

Negative impacts of AI

All of the above examples give a very favourable view of the effect of AI on our everyday lives. However, in any balanced argument, we should also consider the drawbacks of the new technology:

» Could lead to many job losses in several areas (although it is true to say that new technical jobs would also be created); many jobs could be lost in manufacturing, but other roles are likely to be affected

» Dependency on technology and the inability to carry out tasks done by robots, for example, could be an issue in the future

» Loss of skills – even now, skills from previous generations have been lost as humans have been replaced by machines and software applications.

Extended reality

Extended reality (XR) refers to real and virtual combined environments and is a 'catch all' term for all immersive technologies. The three most common examples now are:

» Augmented reality (AR)
» Virtual reality (VR)
» Mixed reality (MR).

Augmented reality (AR)

The features of augmented reality include:

» Allow the user to experience the relationship between digital (virtual) and physical (real) worlds

» Virtual information and objects are overlaid onto real-world situations

» The real world is enhanced with digital details, such as images, text and animation

» The user can experience the AR world through special goggles or via smartphone/phablet screens

» The user is not isolated from the real world and is still able to interact and see what is going on in front of them

» Examples include the Pokémon GO game which overlays digital creatures onto real-world situations

In the future, augmented reality will have an impact on all the following areas:

» Safety and rescue operations   » Entertainment

» Shopping and retail   » Healthcare

Virtual reality (VR)

The features of virtual reality include:

» The ability to take the user out of the real-world environment into a virtual (unreal) digital environment

» In contrast to AR, the user is fully immersed in a simulated digital world

» Users must wear a VR headset or a head-mounted display which allows a 360° view of the virtual world (this 'fools' the brain into believing they are walking on an ocean bed, walking in an alien world or inside a volcano)

» This technology can be used to good effect in: medicine (teaching operation procedures), construction, engineering and the military

In the future, virtual reality will have an impact on all the following areas:

» Military applications   » Education   » Healthcare   » Entertainment

» Fashion   » Heritage   » Business   » Engineering

» Sport   » Media   » Scientific visualisation

Revision questions

1. March/2023/Paper_0417/12/No.1
(a) Explain what is meant by the term software.
(b) State the two types of software used by computers.

2. March/2023/Paper_0417/12/No.14
Compare RAM and ROM. Your answer must include similarities and differences.

3. June/2023/Paper_0417/11/No.2
Identify the hardware from the descriptions given.
(a) A volatile internal memory that stores the current instruction.
(b) A printed circuit board containing the CPU and other components of a computer.
(c) A printed circuit board that controls the output to a monitor.
(d) A printed circuit board that is installed in a computer so that the computer can be connected to a network.

4. June/2023/Paper_0417/11/No.10
Some people use dialogue-based user interfaces to operate their car audio system.
(a) Describe what is meant by a dialogue-based user interface.

5. June/2023/Paper_0417/12/No.11
Movies can be stored on Blu-ray discs or an internal hard disk.
(a) Describe why Blu-ray discs are preferred to an internal hard disk for storing movies.
(b) Hard disks and Blu-ray discs are examples of backing storage.
(i) State two characteristics of backing storage.
(ii) Identify two other types of backing storage.

6. Nov/2023/Paper_0417/11/No.9

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Rowena's laptop computer contains a small capacity Solid State Drive (SSD) of 32Gb and a large capacity Hard Disk Drive (HDD) of 1024Gb.

(a) State, giving a reason for your choice, a use for the SSD and a use for the HDD in the laptop computer. Your answers must be different in each case.

(i) SDD

(ii) HDD

(b) The laptop computer also contains internal memory.

Give two examples of internal memory.

7. Nov/2023/Paper_0417/12/No.2

A computer system uses both analogue and digital data.

(a) Explain what is meant by these types of data.

(i) analogue data

(ii) digital data

(b) Digital data is processed in a computer system. Sometimes digital data needs to be converted to analogue data. Explain why digital data may need to be converted to analogue data.

8. Nov/2023/Paper_0417/12/No.5

A group of pupils is planning to create a newsletter for a history project. The group can either use a smartphone or a phablet computer.

(a) Explain what is meant by a phablet computer.

(b) Discuss the advantages and disadvantages of using a phablet computer rather than a smartphone for this project.

9. Nov/2023/Paper_0417/12/No.6

Many teachers use multimedia projectors in their lessons.

(a) State two health issues associated with the use of multimedia projectors.

(b) State two safety issues associated with the use of multimedia projectors.

10. Nov/2023/Paper_0417/13/No.7(a)

Rockit Aircraft manufactures and flies aeroplanes.

(a) The pilots at Rockit Aircraft are trained using extended reality.

Describe what is meant by extended reality.

11. March/2024/Paper_0417/12/No.2

A computer system consists of both hardware and software.

(a) Explain what the following types of software provide in the computer system.

Applications

System

(b) Give two examples of each type of software.

(i) Applications

(ii) System

12. March/2024/Paper_0417/12/No.3
There are two forms of data: analogue and digital.
Contrast analogue and digital data.

13. March/2024/Paper_0417/12/No.4
Computers contain a Central Processing Unit (CPU).
Describe the role of the CPU in processing instructions to produce an output.

14. March/2024/Paper_0417/12/No.5
A doctor uses a gesture-based user interface.
State two other types of user interface.

15. March/2024/Paper_0417/12/No.6
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Augmented Reality can be used with a Global Positioning System (GPS) device.
(a) State two other uses of Augmented Reality.
(b) Describe the differences between Augmented Reality and Virtual Reality.