

Booklet 5

This covers the following topics found in section 5 of the computer studies syllabus:

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5.1 Hardware

Laptop/notebook computers

Laptop computers have the obvious advantage over desk top computers (PCs) in that they are fully portable. This is of particular value if a user wishes to do work away from the office (e.g. when travelling) or if they want the freedom to work anywhere within a building taking full advantage of WiFi technology.

One of the main considerations when buying a laptop is the battery life. This can depend on a number of things but one major factor is the processor specification. The following is a list for consideration:

- the processor should consume as little power as possible thereby prolonging internal battery life
- the processor should run as cool as possible minimising the problems associated with heat dissipation
- no fans needed to cool the processor thus reducing the load on the internal battery

The main disadvantages of laptops compared to desk top PCs are:

- they tend to be more expensive to purchase
- it is easier to steal a laptop
- security risks (if sensitive data is stored on the internal hard drive)
- laptops tend to have a lower specification than an equivalent desk top computer

Household devices

(Note: also check out the section on *Embedded web Technology* in booklet 1)

Many household devices now use microprocessors to control their various functions. The following is just a sample of common devices (showing some of the functions controlled by the microprocessor and general notes on the application; it is worth doing further research to find out more about these devices):

Digital cameras

The microprocessor would be used to control the following functions, for example:

- shutter speed
- lens focus
- flash
- aperture (light intensity)

(Note 1: the sensitivity of the camera depends on the number of pixels used to represent the picture taken e.g. an 8 megapixel camera takes a sharper image than a 5 megapixel camera. The camera memory size also dictates how many photos can be taken or limits the pixel size of a photo. The sharpness of the image also depends largely on the lens quality.

Note 2: the advantages of digital cameras over manual cameras include: no processing costs (since there is no need to develop film or make prints), easy to delete unwanted photos, direct transfer of photos from camera to computer through the USB port (no need to scan in photos), easier to modify photos on screen (e.g. crop, change colour density, etc.) etc.)

Washing machines

The microprocessor would be used to control the following features, for example:

- water temperature
- time for each cycle
- the wash cycle (when to add powder, when to rinse, etc.)
- loading (i.e. weight of the washing in the drum)

(Note 1: the main advantages are that these machines are fully automatic (wash programs are fully stored) which makes them easy to use, they are cheaper to manufacture (modular design) and generally more reliable).

Digital televisions

The microprocessor would be used to control the following features, for example:

- automatically tuning into television stations
- allow digital signals to be decoded
- since constantly monitoring signal strength (etc.) far better sound and picture quality result)
- allows interface with many devices
- controls picture and sound quality (factory settings can be stored, etc.)
- in built diagnostics in case of faults

(Note 1: signals to televisions are now sent digitally so need a computer to interpret and decode these signals into a picture/sound; need multi-functional system to control plasma and LCD screens)

Input and output devices

Input and output devices need to be matched up to the computer application. Several of these have been covered already in booklet 1:

- computer-aided design (large screens, graph plotters, etc.)
- virtual reality (data goggles, data gloves, etc.)
- control/monitoring applications (sensors, ADC/DAC, actuators, etc.)

Other examples include:

Information centres

Airports, supermarkets, and any application where information needs to be relayed to customers, gain benefit from having automatic information kiosks rather than having manned desks. These allow customers to automatically obtain information when they require it. Output is normally on a screen but the input devices can vary and are usually:

- touch screens (with menu options)
- mouse/trackerballs to select options
- limited options keyboard
- light pens (although these are becoming increasingly less common)

(keyboards are usually not offered since the number of options is limited and the owners of the system don't want customers keying in information and attempting to "hack" into the system).

Using this automated information system affords the following advantages to the customers and company:

- the system can be linked into websites to give live updates (very useful option at airports, bus terminals, railway stations, etc.)
- information is usually more up to date using this method
- no language problems (manually operated desks may have limited language capability)
- no need to wait in queues
- companies can advertise special offers, special services, key notices, etc.
- lower costs to companies (fewer staff needed)
- automatic information kiosks are always open

Supermarkets/retailers

These use several types of specialist input/output hardware. For example:

- bar code readers/scanners (to read product details and enable automatic stock control)
- Point of Sale (POS) terminals – usually include the bar code readers/scanners
- CAD output/input devices (the supermarkets produce their own notices etc. and need this specialist hardware to carry out these tasks)
- sensors (counting customers entering and leaving the supermarket to allow efficient check out performance)

Facilities for the disabled

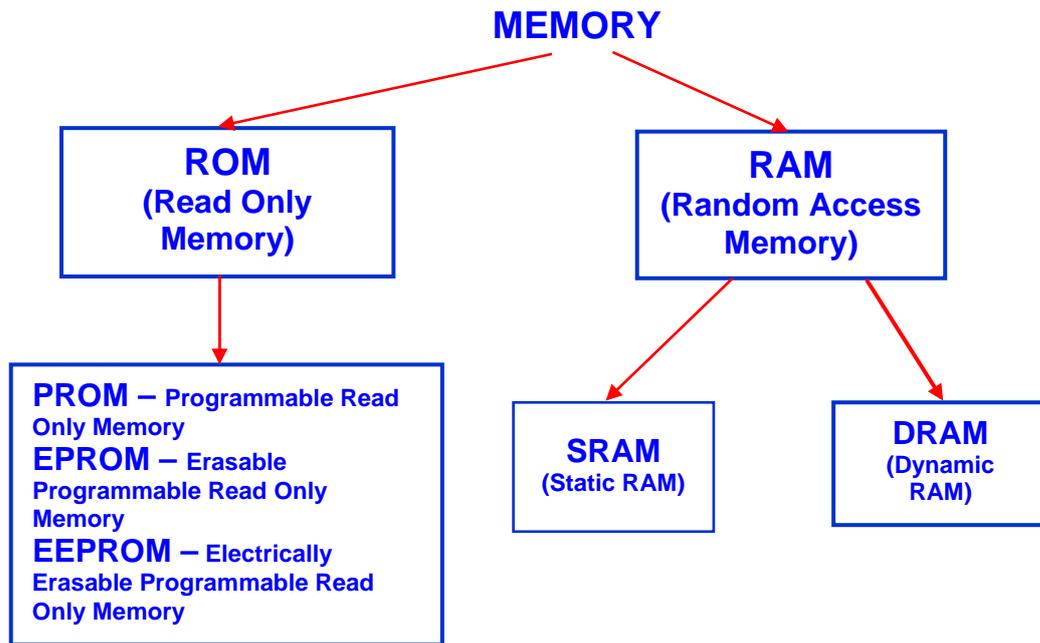
There are many input/output devices to help disabled people. Some of these are summarised below:

Device	Application
Touch screens + head wand	For people who can't use a keyboard allowing input; also helps people with learning difficulties since icons are easier to understand
On-screen keyboards	For people who can't use keyboards (use head wand to select letters)
Voice recognition	Blind and partially-sighted people can communicate with a computer using microphone and software (keyboard and touch screens can't be used)
Trackerball	Easier to use than a mouse if people have problems using their arms and hands or if they have a coordination problem
Large font size/use of colour	Helps people who are partially-sighted since the larger icons and/or colourful outputs on large screens are much easier to see
Braille printers	Dot matrix printers can be modified to produce raised dots (i.e. Braille) – this helps blind and partially-sighted people to read the output
Voice synthesis	Loud speakers and special software are used to output information in the form of sound to help blind and partially-sighted people; it also helps people who have difficulty reading/understanding text
Large/concept keyboards	These help people who have difficulty using normal keyboards (either because of difficulty using hands/arms or coordination problems)
Prediction software	To help dyslexic people when typing
Foot activated controls	To allow people with restricted hand/arm movement to communicate

5.2 Computer Memories

Computer memories are either internal or external. Internal memories are either ROM (read only memory) or RAM (random access memory). External memories can take on many forms (and discussed in some detail later).

The first part of this discussion considers **internal memory systems**:



Read only memory (ROM)

ROM holds the instructions for starting up the computer. This type of memory can only be read and cannot be altered (i.e. deleted or written to) and is non-volatile (i.e. it doesn't lose its contents when the computer is switched off).

Programmable read only memory (PROM)

A PROM is a memory chip on which data can be written only once. Once a program has been written onto a PROM, it is permanent. Unlike RAM, PROM's retain their contents when the computer is turned off. The difference between a PROM and a ROM (read only memory) is that a PROM is manufactured as a blank memory, whereas a ROM is programmed during the manufacturing process. To write data onto a PROM chip, a special device called a PROM programmer or PROM burner is required.

Erasable programmable read only memory (EPROM)

This is a special type of PROM that can be erased by exposing it to ultraviolet (UV) light. Once it has been erased, it can be re-programmed using an EPROM burner.

Electrically erasable programmable read only memory (EEPROM)

An EEPROM is a special type of PROM that can be erased by exposing it to an electrical charge. Like other types of PROM, EEPROM retains its contents even when the power is turned off. Also, as with other types of ROM, EEPROM access time is not as fast as RAM. EEPROMs are similar to flash memories (sometimes called flash EEPROM). The principal difference is that an EEPROM requires data to be written or erased one byte at a time, whereas a flash memory allows data to be written or erased in whole blocks.

Random access memory (RAM)

This is a volatile memory (i.e. contents are lost when the computer is switched off). A user can write or delete data as well as read the contents. Before a program can be ran it must first be loaded into RAM which allows the CPU to access the program. Battery-backed RAMs overcome data loss on switching power off, but are outside the scope of these booklets.

(NOTE: For completeness, it is worth mentioning that two types of RAM exist called SRAM (static RAM) and DRAM (dynamic RAM) – SRAM doesn't need to be constantly refreshed to retain its memory unlike DRAM. Also note that computers use *cache* which is a portion of memory made from SRAM. Memory *caching* works since programs usually access the same data or instructions over and over again. By retaining as much information as possible in SRAM, the computer operates more quickly (*cache* is usually termed level 1, 2 or 3 (termed L1, L2 or L3)).

External storage systems

A number of different types of external memory devices are now available. Some of these are described below (hard drives haven't been mentioned since these are **usually** internal; hard drives contain much of the applications software to enable the computer to run effectively).

MP3 (MPEG-3)

MPEG-3 uses an audio compression technology; it compresses CD-quality sound by a factor of about 10 whilst retaining most of the quality e.g. a 60 Mbyte CD track is turned into a 6 Mbyte MP3 file. Music data is often stored on an MP3 player which plugs into the computer through a USB port. The music data is downloaded to the MP3 player where it is stored in a file. The player has its own internal battery which allows a user to listen to the music files through personal head phones or connect the player to an external sound amplification unit. Variations of MP3 players (e.g. I-pods) exist which use their own file structures when storing music; these require compatible software to enable files to be stored in the correct format.

MP4 (MPEG-4)

MPEG-4 files are in a format that can hold a mixture of multimedia objects such as audio, video, images, animation, etc. MP4 players again use compression technology to store data in files. They operate in much the same way as MP3 players described above.

Flash memories

These are non-volatile re-writable memories evolved from the EEPROM; they are often connected to the USB port on the computer enabling a user to transfer files between computers.

SD (secure digital) cards are a type of flash memory used in digital cameras and mobile phones. XD (extreme digital) cards are also a type of flash memory used in digital cameras and are similar to SD cards.

Compact disks (CD)

These are an optical storage media which have basically taken over from the floppy disk. Software is now usually supplied on a CD (in the form of CD-R which can be read only or CD-RW which allows reading and writing of data).

Digital versatile disk (DVD)

This is an optical system for storing data. It is similar to CD but typically can hold 4.7 Gbyte of data compared to only 700 Mbyte of data on a CD. This is due to dual layering and higher density of data storage.

Credit cards and smart cards

Credit cards contain a magnetic stripe on the back which is made up of iron-based particles in a plastic film.

The stripe is split up into three tracks which are read by a magnetic stripe reader. Usually only tracks 1 and 2 are used. The information stored usually follows the following format:

<u>track 2</u>	<u>track 1</u>	<u>description</u>
√	√	start sentinel (1 character only)
	√	format code ("B") (1 character only)
√	√	account number (19 characters)
√	√	separator (1 character only)
√	√	country code (3 characters)
	√	name (between 2 and 26 characters)
	√	separator (1 character only)
√	√	expiry date or separator (4 or 1 character(s))
√	√	service code (3 characters)
√	√	optional data to fill up (max record length – 79)*
	√	end sentinel (1 character only)
√	√	character check (1 character only)

(* the optional data often contains a PIN verification code or card verification code)

Smart cards are discussed in detail in booklet 1.

Sensors

Numerous types of sensors are used to give real time information to computers (see data capture devices in booklet 1). Frequently, an analogue to digital converter (ADC) is needed since sensor data is often in analogue form and computers can only process digital data. The following is a list of common sensors and examples of applications which make use of these sensors:

Sensor type	Possible applications	
temperature	(1) (2)	used in controlling central heating systems used to control/monitor temperatures in chemical processes
moisture	(1) (2)	monitoring of greenhouse environment any process where moisture is an issue (e.g. production of tablets in a pharmaceutical company)
oxygen	(1)	environment (e.g. measuring oxygen content in a river to check for pollution)
light	(1) (2) (3)	growth control in a greenhouse traffic lights to detect the presence of a vehicle on automatic doors to detect the presence of a person
infra red	(1) (2)	detecting an intruder by breaking an infra red beam counting (e.g. counting coins as each one breaks the beam)
pressure	(1) (2)	detecting intruders in a burglar alarm system some systems still use these to count vehicles on the road
acoustic	(1) (2)	picks up sound (e.g. burglar alarm system) detecting liquids moving in pipes (chemical processes)
motion	(1)	detecting speed (e.g. radar guns measuring vehicle speed)
pH	(1) (2) (3)	used to measure acidity in rivers (pollution monitoring) used in greenhouses to monitor soil acidity used to monitor/control chemical process where acidity levels are important
proximity/distance	(1)	these tend to be versions of the above (e.g. light or infra red)

5.3 Systems

Operating Systems (OS)

The operating system (OS) is a program that, after being initially loaded into the computer by a *boot program*, manages all the other programs/applications. On a PC, the first program that runs is stored on a ROM chip. This program checks the system hardware to make sure everything is functioning normally. This checks the CPU, memory and *basic input-output systems (bios)* for errors. If all is satisfactory, the BIOS will activate the disk drives. When the hard drive is activated, the OS is found in the *boot* and is then loaded.

The following is a list of functions carried out by various operating systems:

- provides a user interface
- device management (input/output control)
- security (e.g. log on, passwords, etc.)
- handles interrupts
- spooling
- memory management
- multitasking
- batch processing
- multiprogramming
- error reporting and handling
- loading and running software
- processor management
- maintain user accounts
- utilities (such as copy, save, re-name, etc.)

Many household appliances that are microprocessor-controlled don't have operating systems (e.g. microwave oven, fridge, etc.). The microprocessor has just one set of tasks to perform; essentially straightforward inputs are expected (e.g. a keypad on the front of a microwave oven) and they have simple never-changing hardware to control. Thus, it isn't necessary to have an OS; thus leading to reduced development and manufacturing costs for the household devices.

Batch processing

In this process, a number of tasks (or jobs) are all collected together over a set period of time. They are then all loaded into the computer system (in a job queue) and processed in one go (or batch). Once a batch job begins, it continues until it is completed or an error is encountered. No user interaction is required once execution begins.

This has the advantage that jobs can be processed when computer resources are less busy (e.g. during the evening or at night); thereby utilising an expensive resource. Batch processing is often used in the following application areas:

- billing systems (gas, electricity, water, etc.)
- payroll systems
- processing cheques

Real time (transaction) processing

When booking seats on a flight, for example, real time (transaction) processing would be used. Response to a query needs to be very fast and once a seat is booked it needs to be marked as "not available" immediately to avoid any risk of double booking. Using this example of booking seats on a flight, the following sequence of events would take place:

- customer/travel agent contacts the airline
- the customer/travel agent types in the day/time of flight and number of travellers
- the customer/travel agent types in the departure airport and the destination airport
- the airline database is searched and availability of seats checked
- if seats are available on the required day/time then a booking is made
- the database/file is updated immediately to indicate that these seats are no longer available and prevents double booking from occurring
- if no seats are available a message is sent back to the customer/travel agent
- this uses real time (transaction) processing since the files are updated in real time; interrogation of files will have access to totally updated information

(NOTE: the above is sometimes referred to as *pseudo real time* since some applications don't need immediate updating of the files)

Real time process control

Process control is a real time system. But this is very different to real time (transaction) processing; this system usually involves sensors and feed back loops i.e. the output can influence the next input to the system.

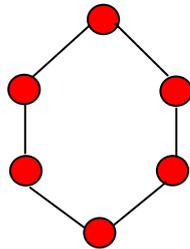
Sensors send data (via an analogue to digital converter – ADC) to a computer or microprocessor which decides whether or not to take action (based on comparison with stored data). If a change needs to be made, the computer/microprocessor sends signals (via a digital to analogue converter – DAC) to the devices being controlled and alters their status (e.g. turn a heater on if a temperature sensor indicates that a temperature is too low) – actuators are often used to open valves, turn on equipment, etc. As this is continuously monitored, eventually the temperature will equal the stored value in the computer/microprocessor – this will then cause the heater to be turned off. The role of sensors is also discussed earlier in this booklet and also in some depth in booklet 1.

In real time (transaction) processing files are often updated in real time (e.g. when booking flights on an airplane); but in real time process control, physical quantities (such as temperature) are continuously monitored and the input is processed sufficiently quickly to be capable of influencing the data source.

Networks

For types of network topology are briefly described here.

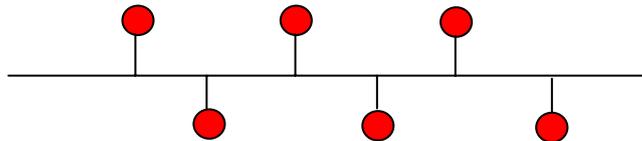
Ring networks:



Comments

- 1 - a faulty connection between two stations can cause network failure
- 2 - it is difficult to add a new station/device as it has to come between 2 existing stations
- 3 - this type works well during heavy loading
- 4 - it is possible to create large networks using this topology

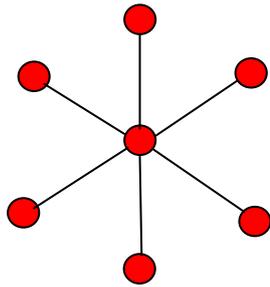
Bus networks:



Comments

- 1 - requires less cabling than a *star* network
- 2 - if there is a central cable problem the entire network goes down
- 3 - less expensive network than the other systems
- 4 - works best with a limited number of stations; performance worsens as new stations added

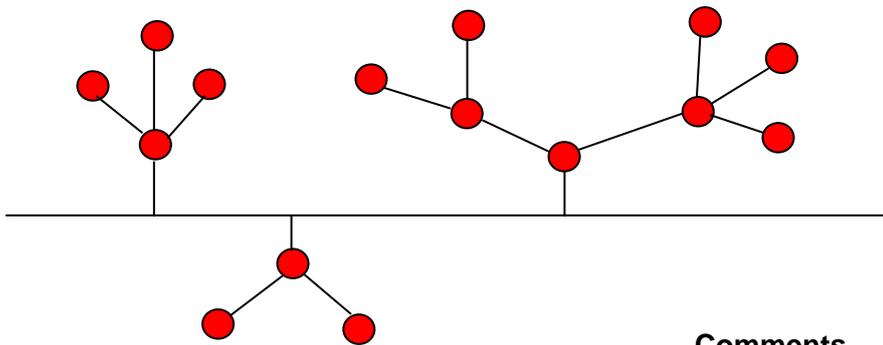
Star networks:



Comments

- 1 - if one station/connection fails the other devices are not affected
- 2 - if the central hub breaks down, the whole network fails
- 3 - it is easier to identify faults using this type of topology
- 4 - it is easy to expand this type of network

Tree networks:



Comments

- 1 - this features *star nodes* on a *bus* network
- 2 - all the advantages and disadvantages of both types of networks described above apply to this system; it is quickly gaining in popularity since it has all the good features of *bus* and *star* topologies

Multimedia applications

Multimedia involves the use of a computer to present:

- text
- graphics
- video
- animation
- sound

in an integrated form. It has its main uses in:

- commercial applications (advertising, journalism, presentations, etc.)
- entertainment (special effects, video games, fine arts, etc.)
- education (CBT training, uses in virtual reality training, etc.)

5.4 Problems

A list of examination-based problems now follows. These can be used as revision questions or centres can use the questions to make up their own assessments to give candidates practice under examination conditions.

- (1)
 - (a) Name **two** household appliances that are microprocessor controlled.
 - (b) Describe what functions the microprocessor controls in the named appliances.
- (2)
 - (a) Name **four** different types of sensors and give an application for each one named.
 - (b) Choose **one** of your named applications and describe how the sensors are used to control and monitor it.
- (3)
 - (a) Describe the main differences between Random Access Memory (RAM) and Read Only Memory (ROM).
 - (b) Various external, removable memory devices exist. Choose which device (using a **different one** in each case) you would use for the following, and give a reason for your choice:
 - (i) storing multimedia files
 - (ii) storing music files
 - (iii) storing documents produced on a word processor

- (4) A number of specialised input/output devices have been developed to help disabled people use computer systems.

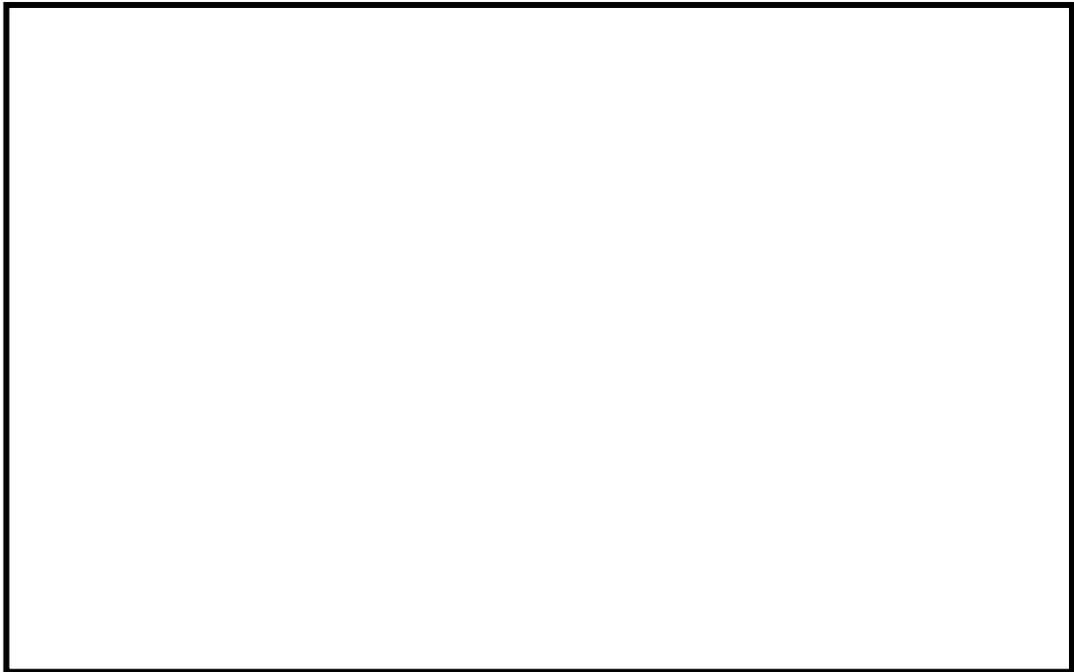
Name **three** input/output devices and describe how they would help a disabled person.

- (5) Compare the type of data that would be stored on a barcode with the data that would be stored on a credit card magnetic stripe.

Describe the different types of validation checks that would be made on data stored on:

- (i) barcodes
- (ii) magnetic stripes on credit cards

- (6) A railway station management team has decided to set up automatic information kiosks to keep passengers up to date with train times, cancellations, and general information.
- (a) Which input devices could be used at these information kiosks?
 - (b) What advantages do these kiosks give customers compared to an information desk manned by a human operator?
 - (c) What advantages does this system give to the station management?
 - (d) Using the space below show a typical “home page” which could be presented to passengers at the railway station. Show any links, menus, etc. which you think would be needed to make the system as user friendly as possible.



- (7)
- (a) Give **four** functions carried out by a typical operating system.
 - (b) Describe the main differences between *real time (transaction) processing* and *real time process control*.
 - (c) Give **two** applications that would use:
 - (i) *real time (transaction) processing*
 - (ii) *real time process control*

- (8) (a) Draw diagrams of a *ring network* and a *star network*
- (b) Give **one** advantage and **one** disadvantage for each of the above network topologies.
- (9) A very large city library is changing over to a fully computerised system to control all their operations.

The training department has been asked to develop a presentation to explain to the library staff how their new system will affect them.

- (a) What features should the trainer use in the design of the presentation to make it as interesting as possible?
- (b) The presentation is to be stored on a laptop computer. What features make the laptop computer ideal for this application?
- (c) Many of the books in the library have been scanned in and stored on the computer.
- What advantages does this give to the customer?
- (10) (a) A music file is 45 Mbyte in length. Approximately how much memory space would this same file need if stored in MP3 format?
- (b) Describe how it is possible to store considerably more data on a DVD than on a CD even though dimensionally they are the same?
- (c) Why have CDs and DVDs taken over from floppy disks as the main secondary storage media on home computer systems?