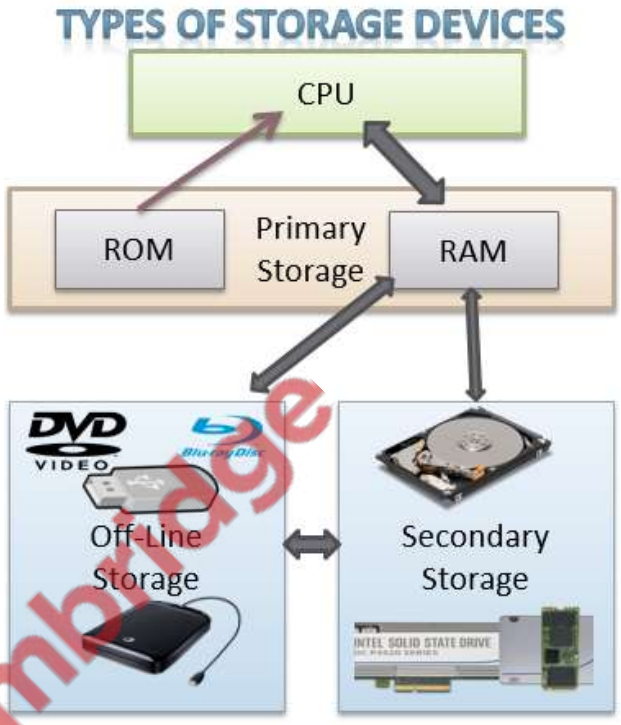
Chapter 5

Storage Devices



Storage Media & Devices

The device that actually holds the data is known as the **storage medium** ('media' is the plural).

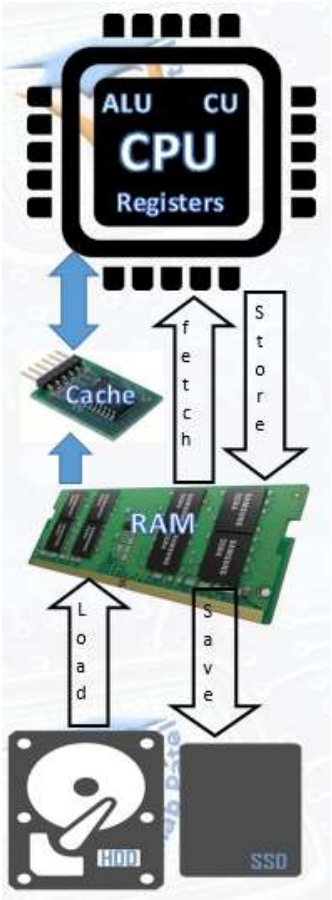
The device that saves data onto the storage medium, or reads data from it, is known as the **storage device**.

Storage Device: The machine which stores data on storage medium.

Storage Media: The physical material in which a devices stores data.

A computer holds programs and data in three sorts of device:

1. Primary — main memory, stores data and instructions to be directly accessed by processor. It has a limited-capacity but rapid-access during processing
2. Secondary — main storage, stores all data and programs. It has larger-capacity but slower-access. They remain inside computer.
3. Off-line — back-up storage, portable, they are removed after read/write data. stores data/programs for future use.



All data and programs are stored in secondary storage. They are loaded n primary storage so as processor can read it. The results of processing is firstly stored by processor in memory and then saved in secondary storage.

Primary memory

Primary memory is also known as 'primary storage' or 'memory'.

Data stored in primary memory can be accessed quickly and directly by the computer's processor.

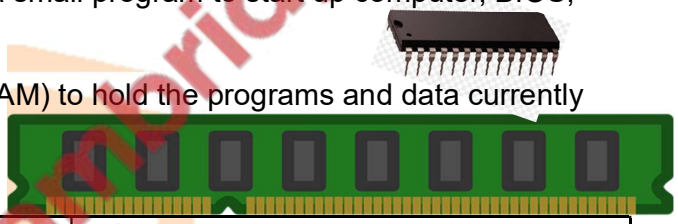
Primary storage is a computer's internal storage. It is in this storage where data is held ready for processing.

Its capacity of primary memory is quite small.

Primary storage is separated into Random Access Memory (RAM) and Read Only Memory (ROM).

Primary memory consists of:

- Non-volatile, read-only memory (ROM) to hold a small program to start up computer, BIOS, firmware, permanent
- volatile, read-write, random access memory (RAM) to hold the programs and data currently being processed, user memory, temporary



Differences between RAM and ROM

	RAM	**ROM**
Applications What they contain?	• Part of Operating system • Currently in use data programs.	• A program used to start the computer called the 'Start-up routine' or BIOS. • Factory setting such as remote control frequencies • stores the set of routines; for example, how the buttons embedded system work
Can the contents be changed? (Is it volatile?)	Yes. The contents of the RAM are changed all the time while the computer is running. It is temporary.	No. The contents of ROM cannot normally be changed. It is permanent.
Who can store data	User	Manufacturer
Volatile or Non-volatile	It is volatile, i.e. it needs continuous power supply to retain data.	It is non-volatile i.e. it can retain data even when there is no power supply.

ROM

ROM stands for **Read Only Memory**. The memory from which we can only read but cannot write on it. This type of memory is non-volatile. The information is stored permanently in such memories during manufacture. A ROM stores such instructions that are required to start a computer. This operation is referred to as **bootstrap**. ROM chips are not only used in the computer but also in embedded systems like washing machine and microwave oven.

Types of ROM

Here are the various types of ROMs and their characteristics.

ROM:	Read Only Memory
PROM:	Programmable ROM
EPROM:	Erasable Programmable ROM
EEPROM:	Electrically Erasable PROM

ROM (or Masked ROM)

The very first ROMs were hard-wired devices that contained a pre-programmed set of data or instructions.

PROM (Programmable Read Only Memory)

PROM is read-only memory that can be modified only once by a user. The user buys a blank PROM. It can be programmed only once and is not erasable.

EPROM (Erasable and Programmable Read Only Memory)

EPROM is a Programmable Read Only Memory. It can be programmed and erased several times by exposing it to ultra-violet light.

EEPROM (Electrically Erasable and Programmable Read Only Memory)

EEPROM is programmed and erased electrically. It can be erased and reprogrammed a numerous times.

Advantages of ROM

The advantages of ROM are as follows −

- Non-volatile in nature
- Cannot be accidentally changed
- Cheaper than RAMs
- Easy to test
- More reliable than RAMs
- Static and do not require refreshing

RAM

RAM Stands for Random Access Memory. It is the essential part of every computer.

It is **Random** because its contents can be accessed randomly.

It is **Access** memory because user can load contents in it, can modify its contents and can erase.

It is **volatile**, it loses all its contents when computer is switched off.

RAM is the only volatile memory in a computer system. It is directly accessible by processor. It is user's memory as user can store data and instructions in it, can modify its contents and can also erase contents of RAM.

RAM stores part of Operating System and currently in use data and programs. In an embedded system, user's settings are also stored in RAM.

All data and programs are saved in secondary storage. On executing the program is loaded in RAM, where it is accessible for processor. It is contents are then fetched in CPU's registers and decoded and executed by CU and ALU.

RAM plays an important role in the efficiency of computer system. Access speed of RAM is faster than secondary storage and slower than registers. Larger the computer memory, faster the execution.

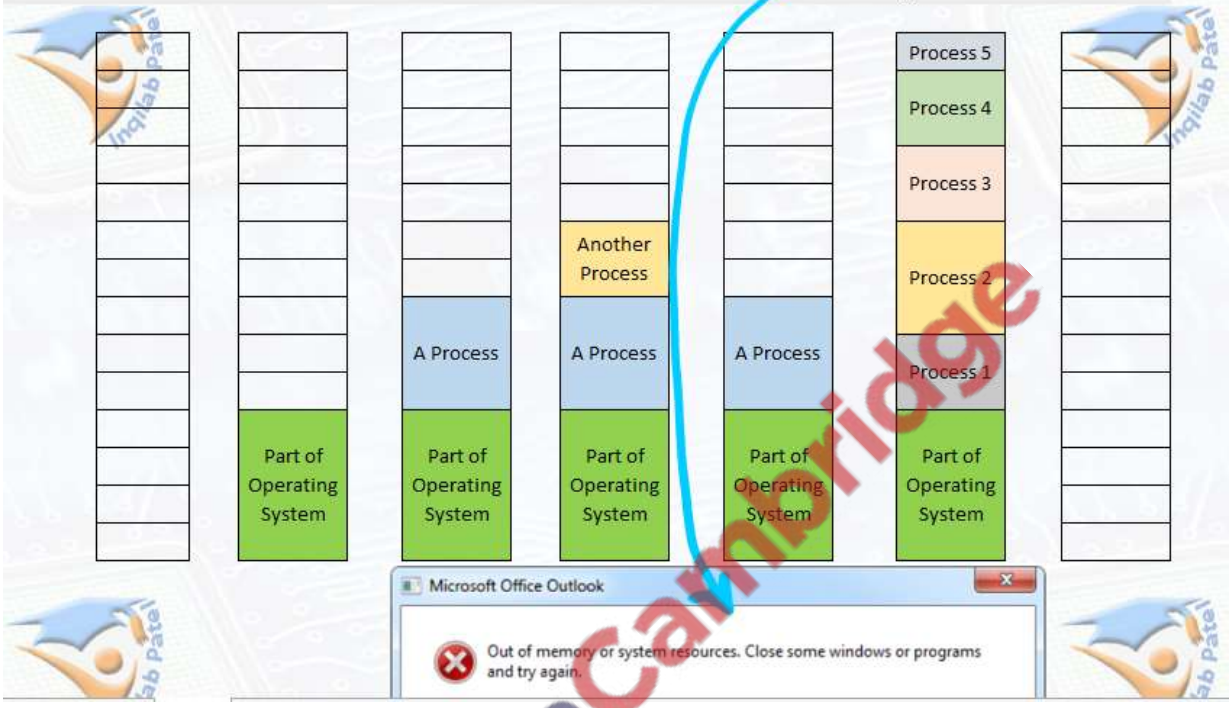
But if too many programs are loaded in RAM, the contents of RAM are increased, it becomes slower, and sometime it shows an out of memory alert message. In this situation virtual memory is used to compensate this shortage of memory.

There are two different types of RAM, Static & Dynamic

SRAM	DRAM
SRAM consists of a number of complex circuits (NAND or NOR). Each circuit stores one bit of data (0 or 1).	DRAM consists of • capacitors to hold bit of data (0 or 1) • and transistors to change capacitors' value like a switch.
NAND and NOR gates never leaks charge so SRAM does not need to be refreshed again and again.	Capacitors leaks charge with passage of time so DRAM requires data to be refreshed periodically in order to retain the data.
requires less power consumption	requires higher power consumption which is significant when used in battery-powered devices
used predominantly in cache memory of processors where speed is important	Commonly used in RAM
Has lesser storage capacity	has higher storage capacity
More expensive	less expensive

Contents of RAM

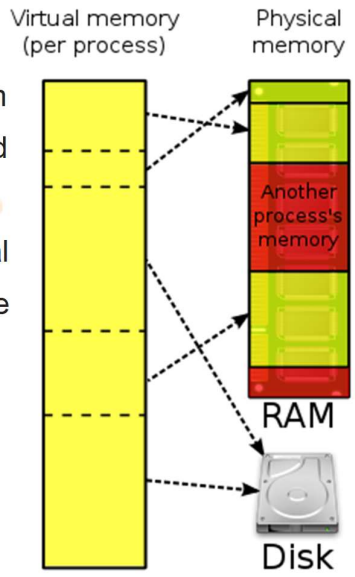
Event	When power is off	on boot up	on Running an app	on Running another app	on closing an app	When too many Apps are open	When power is off
Contents of RAM	nothing is there	Part of OS	OS + Process	OS + Process + Process	OS + Process	OS + Process + Process + ...	every thing is erases

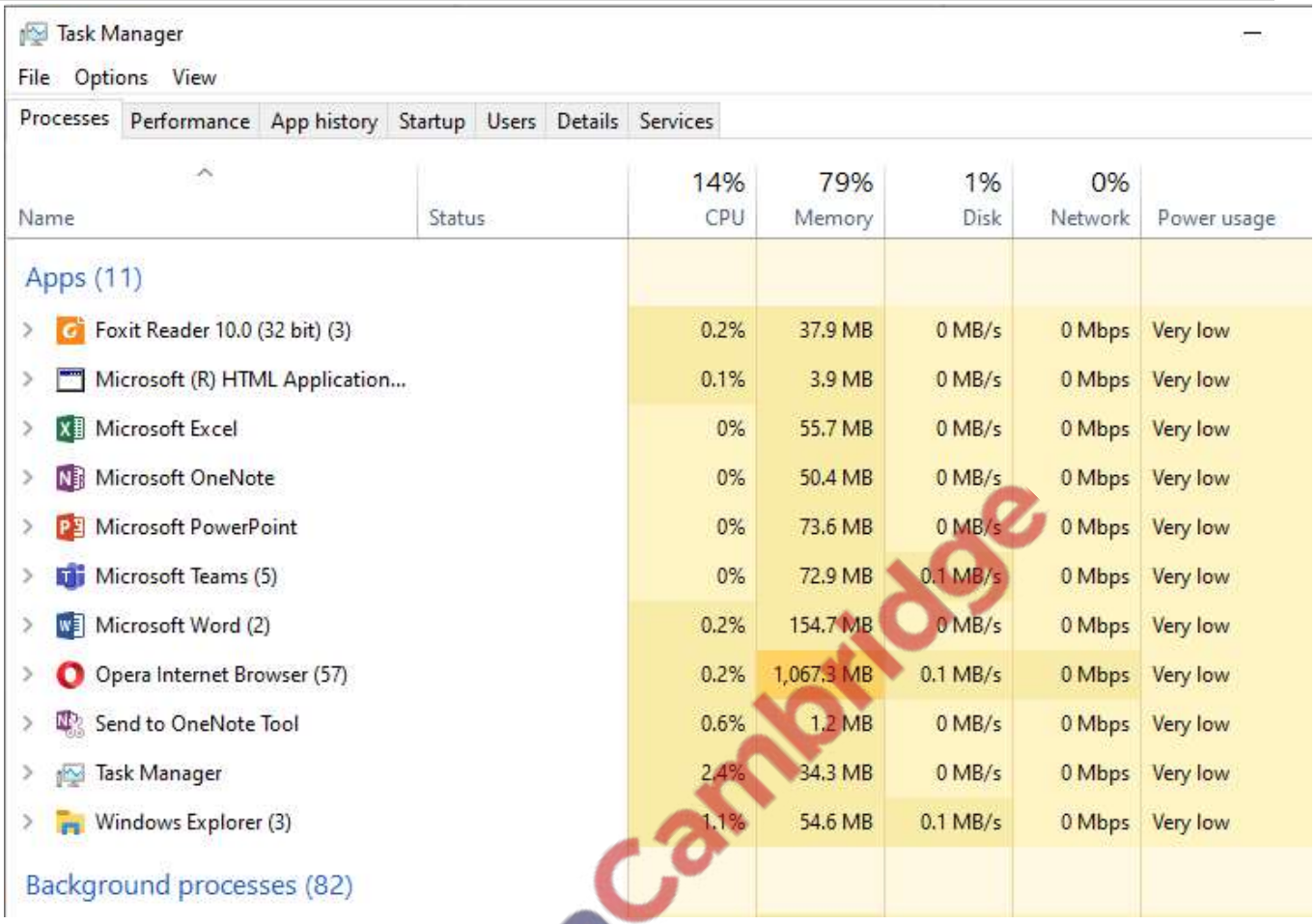


Virtual Memory

Virtual memory is a feature of an operating system that enables a computer to be able to compensate shortages of physical memory by transferring pages of data from random access memory to disk storage. This process is done temporarily and is designed to work as a combination of RAM and space on the hard disk. This means that when RAM runs low, virtual memory can move data from it to a space called a paging file. This process allows for RAM to be freed up so that a computer can complete the task.

Occasionally a user might be shown a message that says the virtual memory is running low, this means that either more RAM needs to be added, or the size of the paging file needs to be increased.





Secondary Storage

The main storage of computer where all data and programs are saved in the secondary storage.

Secondary storage devices are non-volatile. They can retain data even when computer is switched off.

Their storage capacity is much larger than primary memory RAM while access speed is slower.

Secondary storage includes:

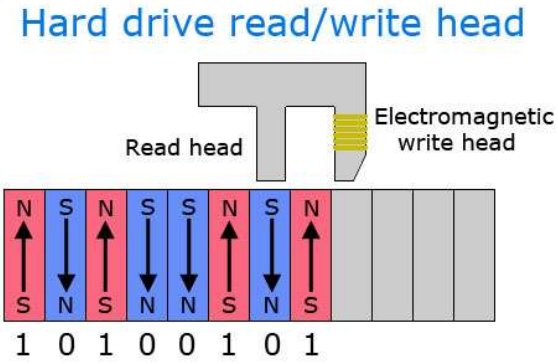
- Hard disks drive (HDD)
- Solid-state drive (SSD)

Hard Drives

HARD DISK DRIVES (HDD) are probably still the most common method used to store data on a computer.

Data is stored in a digital format on the magnetic surfaces of the disks (or platters, as they are frequently called).

- The hard disk drive has a number of platters which can spin at about 7000 times a second. A number of read–write heads can access all of the surfaces in the disk drive.
- Each platter has two surfaces which can be used to store the data.
- These read–write heads can move very quickly – typically they can move from the centre of the disk to the edge of the disk (and back again) 50 times a second.



- Data is stored on the surface in sectors and tracks.
- A sector on a given track will contain a fixed number of bytes.
- Each byte consists of 8 tiny magnetic fields i.e. 1 magnetic field for 1 bit.
- 'O' bit is represented by 'SN' Magnetic field, while '1' is represented by 'NS'.

Unfortunately, hard disk drives have very slow data access when compared to, for example, RAM. Many applications require the read–write heads to constantly seek for the correct blocks of data; this means a large number of head movements.

LATENCY

Latency is defined as the time it takes for a specific block of data on a data track to rotate around to the read–write head.

Users will sometimes notice the effect of latency when they see messages such as 'please wait' or, at its worst, 'not responding'. **Fixed hard disk drives** are available on all computers and are the main method used for data storage.

Internal Operation of Hard Disk Drive

S No	Step
1.	The hard disk has one or more platters made of aluminium or glass
2.	Each surface of the platter/disk is ferrous-oxide which is capable of being magnetised
3.	The disks are rotated at high-speed
4.	Each surface of the disk has a read/write head mounted on an arm positioned just above the surface
5.	Electronic circuits control the movement of the arm and hence the heads
6.	The surface of the platter/disk is divided into concentric tracks and sectors
7.	One track in one sector is the basic unit of storage called a block
8.	The data is encoded as a magnetic pattern for each block
9.	When writing to disk, a variation in the current in the head produces a variation in magnetic field on the disk
10.	When reading from disk, a variation in magnetic field produces a variation in current through the head

Uses

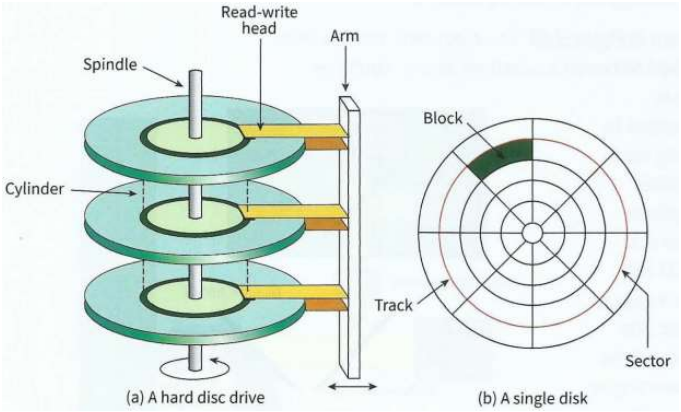
- Fixed hard drives are used to store the operating system and working data.
- They are used for storing applications software that needs fast retrieval and storage of data.
- Real-time systems (e.g. robots, control of a chemical plant) and online systems (e.g. booking airline tickets, automatic stock control (using EPOS)) used fixed hard drives.
- They are used in file servers for computer networks.

Advantages

- They have a very fast data transfer rate and fast access times to data.
- They have very large memory capacities.

Disadvantages

- They can be fairly easily damaged (e.g. if the correct shut-down procedure on a laptop computer has not been correctly carried out and the computer is then moved).
- They lack portability unless a portable hard disk drive is used.



Solid State Drive (SSD)

Solid State Devices uses NAND or NOR chips, by movements of electrons.

These are non-volatile memory.

The term ‘solid-state’ essentially means ‘no moving parts’.

Solid-state storage devices are based on **electronic circuits** with **no moving parts** (no reels of tape, no spinning discs, no laser beams, etc.), so the issue of **LATENCY** is removed. All data is retrieved at the same rate.

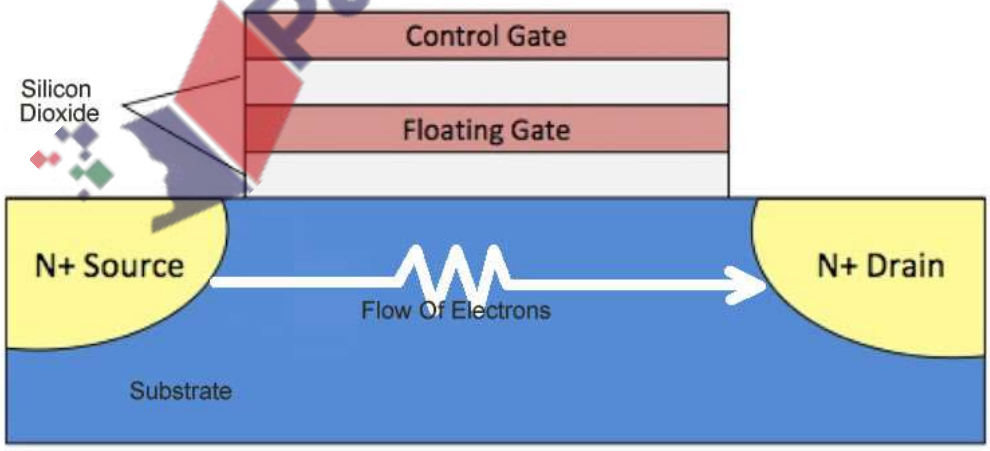
Many of our digital devices (**cameras**, **mobile phones**, **MP3 players**, etc.) require **compact**, **non-volatile** data storage. Flash memory cards provide this and come in a variety of shapes and sizes.

How SSD works

SSD uses NAND or NOR flash memory. It stores data in individual memory cells, using memory transistor. Each transistor composed of:

- a Control Gate, the top layer of transistor.
- A floating gate, the lower segment

The control gate attracts electrons and trapped some of them within floating gate, if electrons are trapped in floating gate, this state is known as bit value 1, and it remain same even there is no power supply. To reset a high voltage is applied which removes the electrons from floating gate.



Attribute	NAND Slid state	NOR Solid State
Storage capacity	High	Low
Cost per bit	Less expensive	More expensive
Access	Allows blocks of data (512 bytes or more) to be read or erased.	Allows data to be read or erased in single bytes at a time.
Write speed	Good	
Read speed		Good
Main application	File storage e.g. SSD & Flash m emory 	Code execution e.g. EEPROM technology. EEPROM technology is used for some security gadgets, such as credit card, SIM card, key-less entry, etc. 

Advantages of SSD over HDD

- they are more reliable (no moving parts to go wrong)
- they are considerably lighter (which makes them suitable for laptops)
- they don't have to 'get up to speed' before they work properly
- they have a lower power consumption
- they run much cooler than HDDs (these last two points again make them very suitable for laptop computers)
- because they have no moving parts, they are very thin
- data access is considerably faster than HDD.

SSD Endurance

Most solid state storage devices are conservatively rated at only 20 GB write operations per day over a three-year period – this is known as SSD endurance. ***For this reason,***

SSD technology is not used in servers, for example, where a huge number of write operations take place every day. However, this issue is being addressed by a number of manufacturers to improve the durability of these solid-state systems.

Flash Memory

Fujio Masuoka, while working for Toshiba, proposed a new type of floating-gate memory that allowed entire sections of memory to be erased quickly and easily, by applying a voltage to a single wire connected to a group of cells. The name "flash" was suggested by Masuoka's colleague, Shōji Ariizumi, because the erasure process of the memory contents reminded him of the flash of a camera.

Flash memory is a non-volatile memory chip used for storage and for transferring data between a personal computer (PC) and digital devices. It has the ability to be electronically reprogrammed and erased. It is often found in USB flash drives, MP3 players, digital cameras and solid-state drives.

Flash memory is a type of electronically erasable programmable read only memory (EEPROM), but may also be a standalone memory storage device such as a USB drive. EEPROM is a type of data memory device using an electronic device to erase or write digital data. Flash memory is a distinct type of EEPROM, which is programmed and erased in large blocks.

Flash memory incorporates the use of floating-gate transistors to store data. Floating-gate transistors, which is a transistor used for amplifying or switching electronic signals. Floating-gate transistors are electrically isolated and use a floating node in direct current (DC). Flash memory is similar to the standard MOFSET, except the transistor has two gates instead of one.

Off-line Storage

Offline storage refers to any storage medium that must be physically inserted into a system every time a user wants to access or edit data. Offline storage can be any type of internal or external storage that can easily be removed from the computer.

Offline storage is also known as removable storage and includes:

- Optical devices like CDs, DVDs
- Solid state USB memory sticks
- External Hard disk

Optical Storage Devices / Media

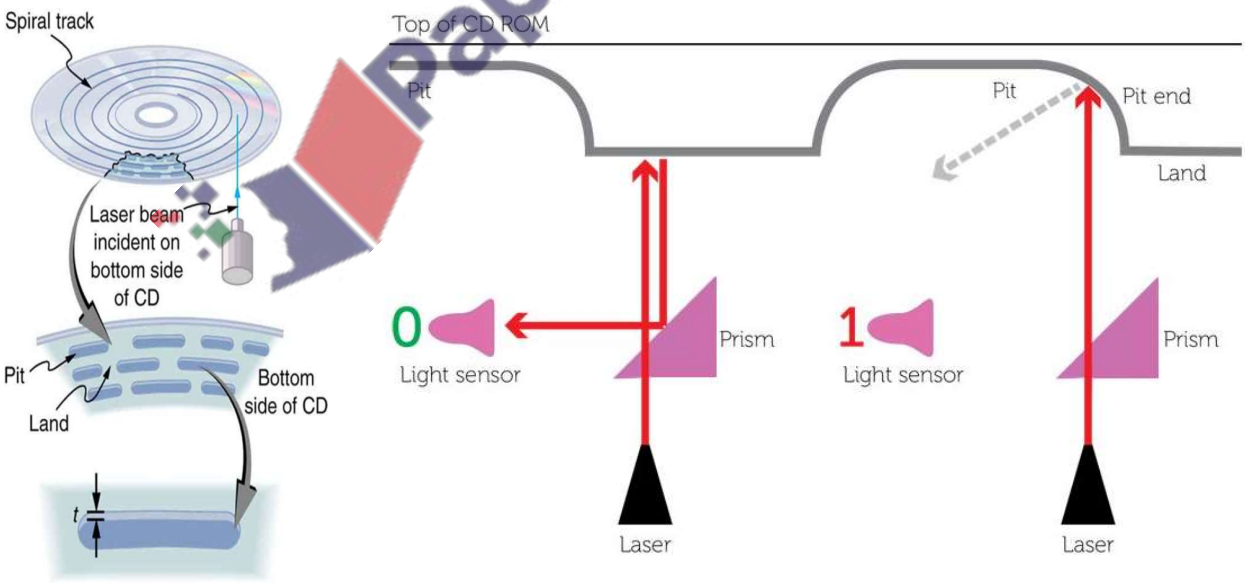
Optical storage devices save data as patterns of **dots** that can be read using **light**. A **laser beam** is the usual light source.

The data on the storage medium is read by bouncing the laser beam off the surface of the medium. If the beam hits a PIT it is **reflected** back differently to how it would be if there was LAND. This difference can be detected, so the data can be read.

PITS can be created using the laser beam (for media that is **writable** such as CD-Rs). The beam is used in a high-power mode to actually mark the surface of the medium, making a PIT. This process is known as '**burning**' data onto a disc.

A CD has digital information stored in the form of laser-created pits on its surface. These in turn can be read by detecting the laser light scattered from the pit. Large information

Stores data as tiny pits pressed into flat surface by laser.



Internal Working of Optical Disk

S No	Step
1.	Drive motor is used to spin the disc
2.	Tracking mechanism moves the laser assembly
3.	A lens focuses the laser onto the disc
4.	Laser beam is shone onto disc to read / write
5.	Surface of disc has a reflective metal layer / phase change metal alloy
6.	Track(s) on the disc have sequence of pits and lands / amorphous and crystalline state
7.	Reflected light in then encoded as a bit pattern

– Optical discs such as CDs and DVDs have smaller capacities than HDDs or tapes and are also more expensive per gigabyte of storage. They are also direct access media, with rather slower access than a HDD, and are removable and highly portable. The main types of CD and DVD have different suffixes, as follows:

– **ROM** stands for 'Read-Only Memory' – these cannot be written to, and are ***suitable for the distribution of music, movies, software and encyclopaedias***

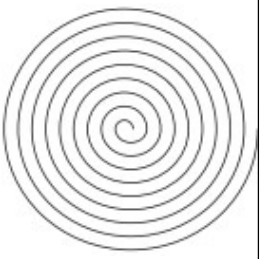
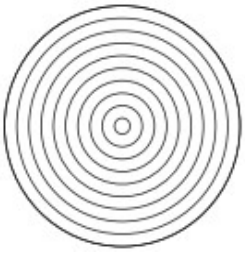
– **R** stands for 'Recordable' – these can be written to just once and then can only be read from, making them ***suitable for storing music or movies or archive copies of documents***

– **RW** stands for 'ReWritable' – these can be written to and read multiple times, making them ***suitable for making temporary copies of data files for transfer from one computer to another or regular backup copies***

DVD-RAM is a DVD (optical disc) technology for high-capacity data storage for computers. Like ordinary random access memory (RAM), it can be repeatedly read, written to, and erased. Intended mostly for removable computer storage, DVD-RAM provides the capabilities of Rewriteable CD (CD-RW) - users can run programs from the discs, copy files to them and rewrite or delete them. However, with a storage capacity of up to 9.4 gigabytes (GB) per double-sided disc, DVD-RAM has many times the capacity of CD-RW.

– **Blu-ray discs (BD or BR)** have larger storage capacities than other optical storage media and a higher rate of data transfer. Although disks are expensive, their cost per gigabyte of storage is nearer to that of a HDD.

Differences between CDs, DVDs, DVD-RAM and Blu-Ray

	CD	**DVD**	**DVD-RAM**	**Blu-Ray**
Track	Single Spiral Track 	Single Spiral Track 	Multiple Concentric Tracks 	Single Spiral Track 
Layer	Single polycarbonate layer	Double polycarbonate layer	Double polycarbonate layer	Single polycarbonate layer
	No **birefringence** as no sandwiched layers	Two sandwiched lays causes **Birefringence**(light is refracted into two separate beams causing reading errors)	Two sandwiched lays causes **Birefringence**(light is refracted into two separate beams causing reading errors)	No **birefringence** as no sandwiched layers
Laser	Uses **red** laser with wavelength of 780 nanometres	Uses **red** laser with wavelength of 650 nanometres Increases storage capacity	Uses **red** laser with wavelength of 650 nanometres. Increases storage capacity	Uses **Blue** laser with wavelength of 405 nanometres. Increases storage capacity
Read/ Write Cycle				Numerous, up to 100,000 times
Head	Single Head so Read or Write at a time	Single Head so Read or Write at a time	Double Head so Read and Write simultaneously	Single Head so Read or Write at a time

The future of optical media

In recent times both the CD and DVD are showing signs of becoming obsolete. Many computer systems now come with USB connectors only and no DVD or CD drive.

The main method of transferring files between devices has become the flash memory.

Many people now store all their music in the following ways:

- on hard disk drive systems
- in MP3 format on:
    - a computer/tablet
    - their mobile phone
    - a portable music player (such as iPod®)
- using the ‘cloud’ to store all their files so they can access their music from anywhere in the world
- by ‘streaming’ their music from the internet; provided the user has an internet connection, they can access music.

Calculating the Storage Requirement of a File

Memory Size Measurement

It should be pointed out here that there is some confusion in the naming of memory sizes.

The unit was established by the **International Electro-technical Commission (IEC)** in 1998, has been accepted for use by all major standards organizations, and is part of the International System of Quantities. The kibibyte was designed to replace the kilobyte in those computer science contexts in which the term kilobyte is used to mean 1024 bytes. The interpretation of the kilobyte to denote 1024 bytes, conflicting with the SI definition of the prefix kilo (1000), is still common, mostly in informal computer science contexts.

The IEC convention is now adopted by some organisations. Manufacturers of storage devices often use the denary system to measure storage size. For example:

0 or 1 = 1 bit

4 bits = 1 nibble

8 bits = 2 niblles = 1 byte

SI Units	IEC Units
1 kilo byte = 1000 byte	1 kibi byte (1 KiB) = 1,024 bytes
1 mega byte = 1000,000 bytes (1000 * 1000)	1 mebi byte (1 MiB) = 1,048,576 bytes (1,024 * 1,024)
1 giga byte = 1,000,000,000 bytes (1,000,000 * 1000)	1 gibi byte (1 GiB) = 1,073,741,824 bytes (1,048,576 * 1,024)
1 tera byte = 1,000,000,000,000 bytes and so on. (1,000,000,000 *1000)	1 tebi byte (1 TiB) = 1,099,511,627,776 bytes and so on (1,073,741,824 * 1,024)

Example Question 1: *A company advertises its backup memory device as having 500 GB of storage. A customer wishes to know how many 8 MB files could be stored on the device. The company claimed that up to 62 500 files (assuming each file is 8 MB) could be stored. The customer calculated that 64 000 files could be stored.*

Explain the difference between these two storage values. Show any calculations you use in your explanation. .....

.....

.....

Marking Scheme

–company calculation is based on 1 GByte = 1000 Mbyte – so (500 × 1000)/8 = 62 500 files

– customer calculation based on 1 GByte = 1024 Mbyte – so (500 × 1024)/8 = 64000 files

– giving the difference of 1500 files [3]

Example Question 2: Bytes, Kilobytes and Megabytes are units used for the amount of data stored in a computer.

(a) State which of these units is most appropriate for the following items of data.

A one page text document: .....

A ten minute movie clip: .....

A person's surname: ..... **[3]**

(b) A computer has a hard disk of 2 Terabytes.

How much is this in Gigabytes?

You **must** show your working.

.....

.....

.....

..... **[2]**

Marking Scheme

a) • *A 1-page text document:* ***Kilobyte(s)***
• *A 10-min movie clip:* ***Megabyte(s)***
• *A person's surname:* ***Byte(s)***
(b) • *Multiply by 1024/1000*
• *2048/2000 (GB)*

Topical Past Papers

Q 1) Summer 2015 P11

5 Five storage devices are described in the table below.
In column 2, name the storage device being described.
In columns 3, 4, or 5, tick (✓) to show the appropriate category of storage.

1	2	3	4	5
Description of storage device	Name of storage device	Category of storage		
		Primary	Secondary	Off-line
optical media which use one spiral track; red lasers are used to read and write data on the media surface; makes use of dual-layering technology to increase the storage capacity				
non-volatile memory chip; contents of the chip cannot be altered; it is often used to store the start up routines in a computer (e.g. the BIOS)				
optical media which use concentric tracks to store the data; this allows read and write operations to be carried out at the same time				
non-volatile memory device which uses NAND flash memories (which consist of millions of transistors wired in series on single circuit boards)				
optical media which use blue laser technology to read and write data on the media surface; it uses a single 1.1 mm polycarbonate disc				

Examiner's Comments on Question 5

The full range of marks were awarded for this question, with very few candidates gaining full marks. Candidates could identify the correct category of storage for most of the descriptions, but many candidates were unable to identify the correct name for the storage device. Many candidates could correctly name ROM and Blu-ray, but not the remaining three.

Q 3) Winter 2015 P12

2 Seven computer terms and seven descriptions are shown below.

Draw a line to link each computer term to its most appropriate description.

Interface	Reduction of file size by permanently removing some redundant information from the file
JPEG	File compression system for music which does not noticeably affect the quality of the sound
Lossless compression	The file is reduced in size for transmission and storage; it is then put back together again later producing a file identical to the original
Lossy compression	Hardware component that allows the user to communicate with a computer or operating system
MIDI	File compression format designed to make photo files smaller in size for storage and for transmission
MP3 format	Standard adopted by the electronic music industry for controlling devices such as synthesisers and sound cards

Examiners´ Comments Question 2

Many candidates gained high marks for this question. Some candidates confused common areas such as lossy and lossless compression.

5 A security system uses sensors, a camera and a microprocessor to capture images of each person entering a large shopping mall.

(a) Describe how the sensors, camera and microprocessor interact to identify certain people entering the mall

.....
.....
.....
.....
.....
.....
.....
.....[5]

(b) Each image taken requires 1 MB of storage. If the camera captures an image every 5 seconds over a 24 hour period, how much storage is required?
Give your answer in **gigabytes** and show all your working.

.....
.....
.....[2]

(c) The shopping mall has over 100 cameras. At the end of each day all these cameras send their images, captured over the last 24 hours, to a central computer.
Explain why the mall uses dedicated fibre optic cable rather than transmitting the data over the local broadband network.

.....
.....
.....
.....[2]

Examiners´Comments Question 5(a) (b) and (c)

In part (a) most candidates gained 2 or 3 marks. Many candidates did not specify any type of sensor that might be used in the system. If the sensor is not specified, this is something they should look to identify in a question of this nature. Some candidates were very generic in their response, speaking of values being compared rather than using the context of the question, for example images being compared.
In part (b) some candidates gained a mark for working out the number of images, a smaller number then made an attempt at calculating the memory requirement for the system.
In part (c) many candidates showed some understanding of the issues, but many were too vague as they did not compare the two types of infrastructure. A surprising number of candidates suggested that fibre optic cable is cheaper than conventional broadband cable.

9 A remote-controlled model car contains RAM, ROM and a solid state drive. The car receives radio signals from its remote control. It can only receive radio signals of a certain frequency. The manufacturer sets this frequency and the owner cannot change it. The owner of the model car can input their own sequence of movements from an interface underneath the car.

(a) Describe the purpose of each of the three types of memory supplied with the car.

RAM: .....
.....
ROM: .....
.....
Solid state drive: .....
.....[3]

(b) The owner needs to be able to enter their own sequence of movements for the model car.
Name a suitable input device.

Input device: .....
.....

Give a reason for your choice of device.

.....
.....
.....[2]

(c) Explain why the model car uses a solid state drive rather than another type of secondary storage.

.....
.....
.....
.....[2]

Examiners´Comments Question 9(a) (b) and (c)

In part (a) many candidates gave a definition of RAM, ROM and SSD rather than relating it to the context of the question. Candidates need to make sure they use a context of a question in their answer, where provided, when appropriate.
In part (b) a surprising number of candidates did not consider where the input device would be placed and therefore gave a range of unsuitable input devices. They again needed to consider the context of the question.
In part (c) most candidates gained at least one mark. A number of candidates suggested that the SSD was more robust, without any explanation. Candidates need to make sure that they clarify statements they make with regard to things such as robustness, reliability and security.

Q 4) Winter 2015 P13

5 A security system records video footage. One minute of video requires 180 MB of storage. The recording system can store several hours of video footage.

(a) Name and describe a suitable storage device for this recording system.

.....
.....
.....
..... [2]

(b) Calculate how much storage would be needed for 2 hours of video footage.
Show your working and give the answer in Gigabytes (GB).

.....
.....
.....
..... [2]

Examiners´Comments Question 5 (a) and (b)

In part (a) some candidate did not consider that the file size would be considerably large and provided an unsuitable device as a result. If candidates are to state a device that has a small storage capacity but can also have a much larger one, for example a USB, they need to make sure they state a suitable size for the USB device.
In part (b) many candidates were able to provide a correct calculation for the question.

9 MP3 file compression reduces the size of a music file by 90%.

(a) A music track is 80 MB in size.
Calculate the file size after compression.

.....
How many MP3 files of the size calculated above could be stored on an 800 MB CD?
.....[2]

(b) (i) Explain how MP3 files retain most of the original music quality.

.....
.....
.....
.....
..... [2]

(ii) State the type of file compression used in MP3 files.

..... [1]

(iii) Name another file compression format.

..... [1]

Examiners´Comments Question 9 (a) and (b)

In part (a) most candidates were able to carry out a correct calculation for this question.
In part (b)(i) some candidates could provide a good level of detail about MP3 file compression. Many candidates gave a vague description of compression itself and could not gain any marks for this. In part (b)(ii) many candidates could provide the correct type of compression, but in part (b)(iii) many candidates provided the opposing compression method, for example lossless and did not provide a file format.

Q 5) Winter 2015 P11

1 **(b)** Describe **two** differences between Blu-ray discs and DVDs.

1: .....

2: .....

.....[2]

(c) Describe **two** differences between DVD-R and DVD-RAM.

1: .....

.....

2: .....

.....[2]

7 (a) Describe what is meant by lossy and lossless compression when applied to files.

Lossy: .....

.....

.....

Lossless: .....

.....

.....[2]

(b) Name and describe **one** type of file that uses lossy compression.

Name: .....

Description: .....

.....

.....[2]

(c) A company advertises its backup memory device as having 500 GB of storage.
A customer wishes to know how many 8 MB files could be stored on the device.
The company claimed that up to 62 500 files (assuming each file is 8 MB) could be stored.
The customer calculated that 64 000 files could be stored.
Explain the difference between these two storage values. Show any calculations you use in your explanation.

.....

.....

.....

.....

..... [3]

Examiners´Comments Question 7(a) (b) and (c)

In part (a) some candidates were able to give an accurate description of lossy and lossless compression, but many candidates were vague in their response and could not obtain marks as a result. Candidates need to make sure they are clear and accurate when providing a description or definition. It must be clear they have a firm understanding of the term or process.
In part (b) many candidates were able to accurately name a file type that uses lossy compression.
In part (c) some candidates were able to gain a mark by stating that measure of bytes used is different 1000/1024. They were vague in their description of this though and did not clearly state what the company and the customer used and why the difference occurred.

9 (b) Nicolae needs to send 30 photos to a friend and he chooses to send all 30 together as a single email attachment. Each photo is 1.8 MB in size, but the maximum possible attachment size is only 20 MB.

State how Nicolae can solve this problem.

.....

..... [1]

Examiners´Comments Question 9(a) and (b)

In part (a) many candidates were able to recognise what was wrong with statement.
In part (b) many candidates were able to identify the file could be compressed.

Q 6) Summer 2016 P11 & P13

11 (a) Four examples of optical storage media are:

- DVD-RW
- DVD-RAM
- CD-ROM
- Blu-ray disc

The table below shows four features of optical storage media.

Tick (✓) the appropriate boxes in the table to indicate which of the features apply to each example of optical storage media. [4]

	Single track	**Many concentric tracks**	**Blue laser used to read/ write data**	**Red laser used to read/ write data**
DVD-RW				
DVD-RAM				
CD-ROM				
Blu-ray disc				

(b) Solid state drives (SSD) are replacing hard disc drives (HDD) in some computers.

(i) Give **three** reasons why this is happening.

1 .....

.....

2 .....

.....

3 .....

..... [3]

(ii) Explain why many web servers still use hard disc drive (HDD) technology.

.....

.....

.....

.....

.....[2]

Examiner Report Question 11(a), (b)(i) and (ii)

In part (a) many candidates were able to recognise the properties of each storage media. The most common error made was in

stating that a Blu-ray disc has many concentric tracks.
In part (b)(i) some candidates were able to describe one reason, this was commonly that they use less power. For many other responses, candidates did not refer to the question in their response. Candidates needed to refer to benefits relating to size, weight and lack of moving parts, being related to the portability of the device.
In part (b)(ii) few candidates were able to provide a reason why HDD was still used. The most common error made was candidates referring to the misconception that SSD cannot be as large in storage capacity as HDD.

Q 7) Summer 2016 P12

4 Nigel wants to send a large text file electronically to Mashuda.

(a) Describe how the size of the text file can be reduced.

.....
.....
.....
.....
.....
.....[3]

(b) This file will be transmitted to Mashuda as an email attachment. Mashuda then stores it on her computer.

Explain how checksums can be used to verify that the file has not been corrupted during transmission or data storage.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....[4]

Examiner Report Question 4(a) and (b)

In part (a) many candidates gained a mark for stating that compression could be used. Some candidates gained further marks by stating the compression method used would be lossless, and describing how this would work. A number of candidates began to describe the two compression methods, both lossy and lossless. They could not be awarded marks for this as the question required candidates to describe one suitable method and the only suitable method was lossless.
In part (b) some candidates gained marks for an accurate description of how a checksum is used. A number of candidates incorrectly referred to Nigel and Mashuda carry out the calculations and the processes. Candidates need to clearly recognise it is the computer and not the person that carries these things out. A number of candidates incorrectly described a detailed process of how to calculate a checksum. The question did not require this, it required candidates to show how it was used in error detection, so this could not be awarded marks.

10 There are **six** descriptions in the table below.
Complete the table below by writing the correct storage device or media in the box next to each description. [6]

Description	**Storage device or media**
Non-volatile memory that can only be read from and not written to.	
Optical storage media that allows very high storage capacity by using blue/violet laser technology.	
Volatile memory that stores data, programs and the parts of the operating system that are currently in use.	
Optical storage media that uses a single spiral track and uses dual layer technology, allowing high data storage capacity.	
Device that stores data by controlling the movement of electrons within a microchip; there are no moving parts.	
Optical storage media that uses concentric tracks allowing writing and reading to take place at the same time.	

Examiner Report Question 10

Many candidates were able to provide suitable storage device. Common errors were the confusion of CD and DVD, and also not being specific enough for sold state, stating USB, but not relating it to being a USB storage device. USB alone can refer to many things.

Q 8) Winter 2016 P12

8 Identify whether the **four** statements about file compression are correct by writing TRUE or FALSE
in the following table. [4]

Statement	**TRUE or FALSE**
MIDI files store the actual music notes in a compressed format	
JPEG files are examples of lossless file compression	
MP3 files are, on average, 90% smaller than the music files stored on a CD	
MP4 files are examples of lossy file compression	

Examiner Report

Very few candidates gained full marks for this question. It was clear that candidates did not have a developed knowledge of file compression. Many candidates were not even aware that MP4 and JPEG are lossy file compression.

Q 9) Winter 2016 P11& 13

10 (b) The current status of the engine is sent to a computer in the aeroplane.
Each piece of data collected is 8 bytes in size. Data collection occurs every 30 seconds.
Calculate the number of kilobytes that would be needed to store the data collected during a 10-hour flight. Show your
working.....
.....
.....

..... kilobytes [3]

Q 10) March 2017 India

7 A high definition video and a large text file are to be sent as email attachments. Both files are compressed before sending. Each file is compressed using a different type of data compression algorithm.
Explain, with reasons, which type of data compression algorithm should be chosen for each file.
.....
.....
.....
.....
.....
.....
.....[4]

Examiner Report
Most candidates correctly stated the appropriate type of file compression for each of the given files. Some candidates then incorrectly went on to describe the type of compression used rather than explaining why that method was chosen.

13 (a) Explain what is meant by primary, secondary and off-line storage. Give an example of each.
Primary storage .....
.....
.....
Example .....
Secondary storage .....
.....
.....
Example .....
Off-line storage .....
.....
.....
Example ..... [6]

(b) A set of photographs has been taken for a wedding. **All** the guests are to be sent digitally stored copies through the ordinary postal service. There are fifty photographs and each photograph is between 1.8 and 2.5 megabytes in size.
Work out the maximum storage space required for a set of photographs. State, with a reason, a suitable medium to use for the copies to be sent to the guests.
Maximum storage space .....
.....
Medium .....
Reason .....
.....
..... [3]

Examiner Report
(a) Many candidates gave vague explanations that were not creditworthy; most candidates could provide at least one correct example.
An example for primary storage that would gain both marks is:
Primary storage is directly accessible by the CPU.
Example RAM
(b) Many candidates correctly calculated the maximum storage space required for the photographs. Some candidates incorrectly suggested the use of email or cloud storage thus not taking into account the statement in the question that copies are to be sent through the ordinary postal service.

Q 11) Summer 2017 P11

3 Steffi has a number of files of different sizes that contain her work. [4]
Tick to show whether each statement is **true** or **false**.

Statement	True	False
47KB is larger than 10MB.		
250bytes is smaller than 0.5MB.		
50GB is larger than 100MB.		
1TB is smaller than 4GB.		

Examiner Comment on Q 3
Most candidates correctly identified which statement was true or false. The most common incorrect answergiven was 'true' given for 47 KB is larger than 10 MB. It was apparent that some candidates understood a KBto be larger than a MB. Candidates are reminded to follow the instruction given and tick (✓) the appropriatebox. Some candidates used crosses (✗) instead or a mixture of both.

8 Complete the paragraph by choosing **six** correct terms from the list.

- Optical
- On-line
- RAM
- HDD
- Primary
- SSD
- Secondary
- ROM
- Off-line

A computer has two different types of memory. ..... memory is not directly accessed by the CPU, but it allows a user to store data that can easily be accessed by applications. Two examples of this type of memory are .....
and ..... . The second type of memory is ..... memory. This memory is directly accessed by the CPU. It allows the processor to access data and instructions that are stored in this memory. Two examples of this memory are .....
and ..... . [6]

Examiner Comment on Q 8
Some candidates gave the correct types and example of storage. Some candidates confused the types ofstorage and gave primary in place of secondary.

Q 12) Summer 2017 P12

2 Give **two** examples of primary, secondary and off-line storage.

Primary
Example 1 .....
Example 2 .....
Secondary
Example 1 .....
Example 2 .....
Off-line
Example 1 .....
Example 2 ..... [6]

Examiner Comment on Question 2
Some candidates demonstrated a good understanding of each storage type, providing correct examples.Some candidates did not have a clear

understanding of the difference between primary and secondarystorage. Many candidates provided two correct examples for off-line storage. It would be beneficial forcandidates to have a greater understanding of what is meant by primary and secondary storage. Somecandidates gave an inaccurate answer for off-line storage e.g. USB rather than USB flash memory. USB canalso refer to the method of data transmission, so is not accurate enough to be awarded a mark.

Q 13) Winter 2017 P12

2 Storage devices and storage media can be categorised as primary, secondary or off-line.
Write **primary**, **secondary** or **off-line** next to each storage device or medium to indicate its most suitable category.

HDD .....

RAM .....

ROM .....

CD-ROM .....

SSD .....

DVD-RAM ..... [6]

8 (a) A computer has 2048MB of RAM.

How many GB of RAM does the computer have?

Show your working.

.....

.....

.....GB [2]

(b) Describe **one** item that is stored in RAM.

.....

.....

..... [2]

(c) Explain **three** ways that RAM is different to ROM.

1 .....

.....

.....

2 .....

.....

.....

3 .....

.....

..... [3]

Q 14) Winter 2017 P13

2 Data files are stored in different file formats.

Complete the table by providing a suitable file format for each file type. The first one has been done for you. [3]

File type	File format
Pictures	.JPEG
Text	
Sound	
Video	

9 (a) Optical storage media can be used to store data.

Describe how the data is read from a Compact Disc (CD).

.....

.....

.....

.....

.....

.....

..... [4]

(b) Kamil wants to store a 16-bit colour image file. The image size is 1000 pixels.

Calculate the size of the file. Give your answer in bytes. Show your working.

Working .....

.....

.....

.....

Answer ..... bytes [2]

(c) Describe the differences between primary and secondary storage.

.....

.....

.....

.....

.....

..... [4]

Q 15) March 2018 P12 (India)

6 Primary, secondary and off-line are types of storage.
Give an example of each type of storage.
For each example state how it is used.

Primary storage

Example .....

Use .....

.....

Secondary storage

Example .....

Use .....

.....

Off-line storage

Example .....

Use .....

..... [6]

Comments on Question 6

Many candidates answered this question well. It would be helpful if candidates understood that providing USB as a response cannot be awarded a mark as this is a method of data transmission. Candidates must provide a storage device, so must indicate that it is a USB storage device.

Some candidates described the storage itself and how it operates, rather than information about what it is used.

9 A 32-second sound clip will be recorded. The sound will be sampled 16000 times a second.
Each sample will be stored using 8 bits.
Calculate the file size in kilobytes. **You must show all of your working.**

File Size ..... kB [3]

Comments on Question 9

Many candidates provided a correct answer for this question. It would be helpful if candidates clea rly showed all the stages of their working in the work space. Some candidates scattered their worki ng around, outside of the provided answer space into other answer spaces, which has the risk of b eing unseen by the examiner.

Q 16) Summer 2018 P11

8 (d) The supermarket uses secondary storage and off-line storage to store data about its stock.

Explain what is meant by secondary storage and off-line storage.

Secondary storage .....

.....

.....

.....

.....

.....

Off-line storage .....

.....

.....

.....

.....

..... [4]

Q 17) Summer 2018 P12

1 Different units of data can be used to represent the size of a file, as it changes in size.

Fill in the missing units of data, using the list given: [4]

- byte
- gigabyte (GB)
- megabyte (MB)
- nibble

Smallest	bit
↓	.....
	.....
	Kilobyte (KB)
	.....
	.....
Largest	Terabyte (TB)

Q 18) Winter 2018 P12

2 A computer uses RAM and ROM to store data.

(a) The table contains three statements about RAM or ROM.

Tick (✓) to show whether each statement describes **RAM** or **ROM**. [3]

Statement	**RAM(✓)**	**ROM(✓)**
Stores the programs and data that are currently in use		
Used to boot up the computer when power is turned on		
Contents are retained when power is turned off		

(b) Circle the storage category that includes both RAM and ROM.

Primary Secondary Off-line [1]

(c) Explain what is meant by off-line storage.

.....

.....

.....

.....[2]

Q 19) Winter 2018 P13

3 An elevator (lift) has a maximum weight limit of 2400 kg. The weight carried is monitored by a sensor and a microprocessor. Describe how the sensor and the microprocessor are used to make sure the maximum weight limit is not exceeded. .....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

9 Describe two differences between Read Only Memory (ROM) and Random Access Memory (RAM).

Difference .....

.....

.....

.....

.....

Difference 2 .....

.....

.....

.....

..... [4]

12 Explain the difference between a Musical Instrument Digital Interface (MIDI) file and a MP3 file.

.....

.....

.....

.....

.....

.....

.....

..... [4]

13 State which types of storage device or media would be most suitable for these scenarios. For each device or media, justify your choice.

(a) Creating a backup of 150GB of data. .....

Justification .....

..... [2]

(b) Storing applications on a tablet device. .....

Justification .....

..... [2]

(c) Storing a 1200MB high-definition promotional movie about a new car. The movie is to be given to people who are interested in buying a new car. .....

Justification .....

..... [2]

Q 20) March 2019 P12

1 (a) Elle has a file stored on her computer that is 20 MB in size. Jordan has a file that is 10GB in size. **Tick (✓)** to show which is the **larger** file. [1]

File size	Tick (✓)
20MB	
10GB	

(b) Bob has a file stored on his computer that is 3500kB in size. Gerty has a file that is 3MB in size. **Tick (✓)** to show which is the **larger** file. [1]

File size	Tick (✓)
3500kB	
3MB	

4 Darius is sending several programs that he has created to his friend Selma.

(c) He wants to compress the files to send them as he needs to attach them to an email. Darius tells Selma he is going to use lossy compression. Selma tells him that he should use lossless instead.

Explain why Selma tells Darius to use lossless compression instead of lossy.

.....

.....

.....

.....

.....

.....

.....

..... [4]

6 (c) Nadia uses several types of computer storage for her homework and other projects.

(i) Five examples of computer storage are given.

Tick (3) to show if the computer storage is **Primary**, **Secondary** or **Off-line**. [5]

Storage example	Primary (✓)	Secondary (✓)	Off-line (✓)
Solid state drive (SSD)			
Blu-ray disc			
USB flash memory			
Random access memory (RAM)			
Read only memory (ROM)			

(ii) Nadia is considering purchasing a magnetic storage device.

Describe how a magnetic storage device stores data.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

(iii) Give **two** advantages of using a magnetic storage device rather than a solid state storage device.

Advantage 1 .....

.....

Advantage .....

..... [2]

Q 21) Summer 2019 P11

5 The following text is stored as a text file:

She sells sea shells on the seashore. The shells that she sells are sea shells I am sure.

Explain how lossless compression would compress this file.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

6 (b) The law company wants to purchase a new file server.

The company can purchase a server with either solid state storage or magnetic storage. After discussion, it decides to purchase a file server with magnetic storage.

Explain why the company chose magnetic storage rather than solid state storage.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(c) The law company also uses optical storage.

Give **three** different examples of optical storage.

1 .....

2 .....

3 ..... [3]

Q 22) Summer 2019 P12

2 A finance company uses off-line storage to archive their accounts.

(a) Explain what is meant by off-line storage.

.....

.....

.....

..... [2]

(b) The computers in the finance company use both primary and secondary storage.

(i) Give **one** example of primary storage.

1 ..... [1]

(ii) Give **two** examples of secondary storage.

1 .....

2 ..... [2]

4 (a) Marley wants to store a video he has created for his school project.

He considers using a DVD or a Blu-ray to store the video.

Explain **two** differences between a DVD and a Blu-ray.

1 .....

.....

.....

.....

2 .....

.....

.....

..... [2]

(b) (i) Marley also needs to store ten 8-bit colour images in a file for his project. Each image is 500 pixels wide and 300 pixels high. Calculate the total file size in megabytes (MB) for all Marley's images.

Show all your working.

.....

.....

.....

.....

.....

.....

.....

File size ..... **MB** [3]

7 (b) A microprocessor uses ROM.

Explain what is meant by ROM.

.....

.....

.....

.....

.....

..... [3]

Q 23) Winter 2019 P13

1 (ii) Identify **two** storage devices that may be used in the library's system.

Storage device 1 .....

Storage device 2 .....[2]

7 The Von Neumann model for a computer system has several components that are used in the fe tch-execute cycle.

(a) One component is main memory.

(i) Describe what is meant by main memory and how it is used in the Von Neumann model for a co mputer system.

.....

.....

.....

.....

..... [3]

Q 24) Winter 2019 P12

1 Computer memory size is measured in multiples of bytes.

Four statements about computer memory sizes are given in the table.

Tick (✓) to show if the statement is **True** or **False**. [4]

Statement	True (✓)	False (✓)
25kB is larger than 100MB		
999MB is larger than 50GB		
3500kB is smaller than 2GB		
2350bytes is smaller than 2kB		

5 Audrey wants to send a sound file to Nico using email.

The file is too large to attach to an email so Audrey decides to compress the file.

She uses lossy compression to reduce the size of the sound file.

(a) Describe how lossy compression reduces the size of the sound file.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(b) Nico asks Audrey why she used lossy compression rather than lossless.

(i) State **one** advantage Audrey could give of using lossy rather than lossless to compress the sound file.

.....

..... [1]

(ii) State **one** disadvantage Nico could give of using lossy rather than lossless to compress the sound file.

.....

..... [1]

(c) Audrey sometimes records MIDI files.

(i) Explain what is meant by a MIDI file.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) MIDI uses serial data transmission.

Explain **two** advantages of using serial transmission rather than parallel transmission.

Advantage 1 .....

.....

.....

.....

Advantage 2 .....

.....

.....

..... [4]

11 Robert has a mobile device that uses RAM, ROM and an SSD.

(a) State what the RAM, ROM and SSD are used for.

RAM .....

.....

ROM .....

.....

SSD .....

..... [3]

(b) Give **two** reasons why an SSD, rather than a HDD, is used in the mobile device.

Reason 1 .....

.....

Reason 2 .....

..... [2]

Q 25) March 20 P12

3 Priya studies music at school. She is buying a new computer to complete her school work at home.

(a) Priya has a choice between an internal Hard Disk Drive (HDD) and an internal Solid State Drive (SSD) to store data.

(i) Give **one** similarity between an HDD and an SSD.

.....

..... [1]

(ii) Explain **three** differences between an HDD and an SSD.

1 .....

.....

.....

2 .....

.....

.....

3 .....

.....

..... [3]

(b) Priya needs to transfer files between the school and her home computer.

Identify **one** off-line storage device she could use to transport the files.

..... [1]

(c) Priya is using sound editing software to record and edit different music tracks.

(i) Identify **two** input devices she would use for this task.

Device 1 .....

Device 2 ..... [2]

(ii) Identify **two** output devices she would use for this task.

Device 1 .....

Device 2 ..... [2]

(d) Priya shares her sound files with other students. Before sharing the sound files, she compresses the files using lossless compression.

Describe how lossless compression reduces the size of a sound file.

.....

.....

.....

..... [2]

(e) Priya currently uses MIDI files to store her music. Priya's friends have asked her if they can have an MP3 version of the file.

(i) Give **two** features of a MIDI file.

1 .....

.....

2 .....

..... [2]

(ii) Give **two** features of an MP3 file.

1 .....

.....

2 .....

..... [2]

Q 26) Summer 20 P12

9 (a) Six statements are given about storage devices. [6]

Tick (✓) to show if the statement applies to hard disk drive (**HDD**) storage or solid state drive (**SSD**) storage.

Some statements can apply to both.

Statement	**HDD** (✓)	**SSD** (✓)
It has a limited number of read/write cycles		
It uses magnetic properties to store data		
It has moving parts		
It is non-volatile storage		
It can be used as an external storage device to back up data		
It uses flash memory to store data		

(b) Optical storage is another type of storage.

Give **two** examples of optical storage.

Example 1 .....

Example 2 ..... [2]

Q 27) 15a Summer 20 P11

1 (d) A smartphone needs both RAM and ROM.
State why a smartphone needs RAM and ROM.
RAM .....
.....
ROM .....
..... [2]

3 (c) Carla wants to reduce the file size of the photos she has transferred to her computer.
She does not want the quality of the photos to be reduced, so she uses lossless compression.
Describe how lossless compression reduces the file size of the photos.
.....
.....
.....
.....
.....
.....
.....
..... [4]

Q 28) Winter 20 P12

1 (c) (ii) She wants to compress the recording to make sure that the file is as small as possible for the website.

Identify which type of compression she should use and describe how this would compress the file for the website.

Type of compression .....

Description .....
.....
.....
.....
.....
.....
.....
..... [4]

(iii) Give **two** benefits of compressing the file for the website.

Benefit 1 .....
.....

Benefit 2 .....
..... [2]

3 Alessandro has some important data stored on his computer.

(b) Alessandro uses an SSD to store his data.

Describe what is meant by an SSD and how it operates to store data.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(c) Alessandro also uses off-line storage to store his data.

Three examples of off-line storage are Blu-ray, CD and DVD.

Six statements are given about off-line storage.

Tick (✓) to show if each statement applies to **Blu-ray**, **CD**, or **DVD**.

Some statements apply to more than one example of off-line storage. [6]

Statement	**Blu-ray (✓)**	**CD (✓)**	**DVD (✓)**
A type of optical storage			
Has the largest storage capacity			
Can be dual layer			
Read using a red laser			
Has the smallest storage capacity			
Stores data in a spiral track			

Q 29) Winter 20 P13

1 Five hardware devices are given.

Tick (✓) to show if each device is an **Input**, **Output** or **Storage** device. [5]

Device	**Input (✓)**	**Output (✓)**	**Storage (✓)**
Solid state drive (SSD)			
Headphones			
2D cutter			
LCD projector			
Microphone			

9 Elle uses both CDs and DVDs to store her school projects.

(a) Give **three** similarities between a CD and a DVD.

1 .....

.....

2 .....

.....

3 .....

..... [3]

(b) State **one** difference between a CD and a DVD.

.....

..... [1]

Q 30) March 21 P12

1 (c) The hockey club wants to increase the number of people that can watch each match to 2000.
The 8-bit binary register may no longer be able to store the value.
Give the smallest number of bits that can be used to store the denary value 2000.

..... [1]

Working space

.....

.....

.....

.....

2 Gurdeep takes high definition photographs using a digital camera. She has set up a website where users can view thumbnails of her photographs. A thumbnail is a small version of the high definition photograph.

(a) Gurdeep compresses the high definition photographs to create the thumbnails. She uses lossy compression.
Describe how lossy compression creates the thumbnails.

.....

.....

.....

.....

.....

..... [3]

4 A supermarket sells many products. Each product has a barcode.

(b) The supermarket stores data using a Solid State Drive (SSD).

(i) Explain how an SSD stores data.

.....

.....

.....

.....

.....

..... [3]

(ii) One advantage of an SSD rather than a Hard Disk Drive (HDD) is that it has no moving parts, so it is more durable.
State **one** other advantage of the supermarket using SSD rather than HDD.
.....
..... [1]

Marking Scheme

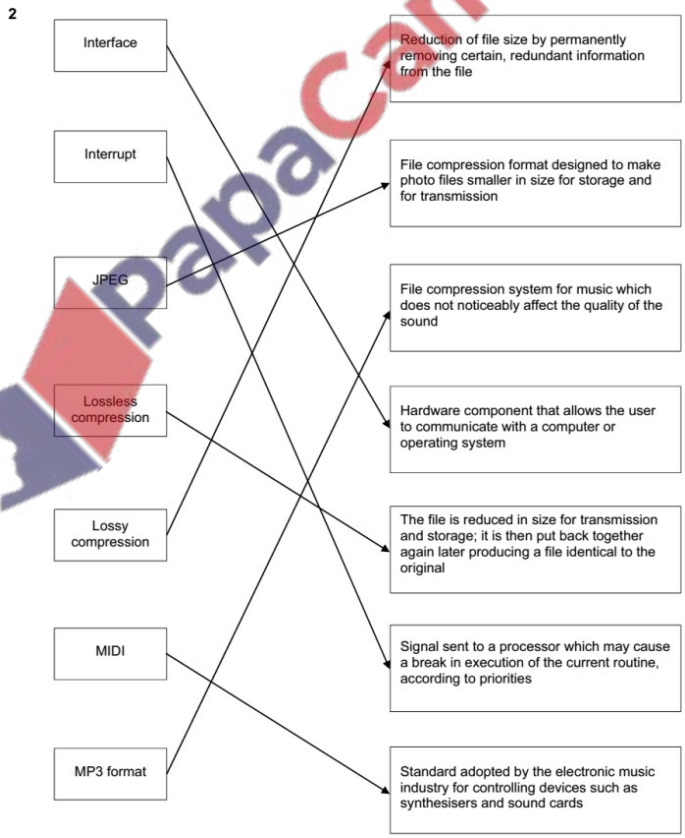
Q 1) Summer 2015 P11

5 **1** mark per device, **1** mark per category

Description of storage device	Name of storage device	Category of storage		
		Primary	Secondary	Off-line
optical media which uses one spiral track; red lasers are used to read and write data on the media surface; makes use of dual-layering technology to increase the storage capacity	**DVD**			✓
non-volatile memory chip; contents of the chip cannot be altered; it is often used to store the start-up routines in a computer (e.g. the BIOS)	**ROM**	✓		
optical media which uses concentric tracks to store the data; this allows read and write operations to be carried out at the same time	**DVD-RAM**	✓		(✓)
non-volatile memory device that uses NAND flash memories (which consist of millions of transistors wired in series on single circuit boards)	**Solid State Drive/memory (SSD)**		✓	
	(SD/XD card) (USB storage device)			(✓)
optical media that uses blue laser technology to read and write data on the media surface; it uses a single 1.1 mm polycarbonate disc	**Blue-ray**			✓

Q 3) Winter 2015 P12

2



5 **(a)** Any **five** from:
- naming a suitable sensor, e.g infra-red, pressure, motion sensors, send signal/data to microprocessor
- signal/data is converted to digital (using an ADC)
- microprocessor instructs/send signals to camera to capture image/video
- captured image/video data sent to microprocessor

either
- microprocessor compares the image/video with stored images/video…
- … if person detected = stored image …
- …alert given to signal a person has been identified

or
- microprocessor compares the biometric data from an image/video with stored biometric data for images/video …
- … if biometric data matched = stored data …
- … alert given to signal a person has been identified

- Continual/repeated process [5]

(b) 1 mark for correct calculation, 1 mark for correct answer
- number of photos = **12 × 60 × 24** = 17 280
- memory requirement = 17 280/1024 = **16.9 (16.875)**
- (17 280/1000 = 17.28/17.3 is acceptable) [2]

(c) Any **two** from:
- (data transmission) is faster
- more secure/safer (because it is a dedicated line)
- (fibre optic transmission) is more reliable [2]

9 **(a)** **RAM**
- contains instructions/program/data currently in use

ROM
any **one** from:
- contains the start-up/bootstrap program
- contains/stores the setting for frequency (can't be changed)

Solid state drive
- stores the instructions/program/data (to operate the car)

(b) 1 mark for device and 1 mark for corresponding reason

Device:
- touch screen
- key pad (NOT keyboard)

Reason:
- easy to use interface
- limited number of options
- small space/space is limited
- other devices such as mouse, keyboard, trackerball, … not suitable

(c) Any **two** from:
- A solid state drive has no moving parts
- A solid state drive has faster random access
- A solid state drive has a quick start up/shut down time (reduced latency)
- A solid state drive is very small
- A solid state drive is very light
- A solid state drive consumes very little power
- A solid state drive does not generate a lot of heat (therefore safer in this application)

Q 4) Winter 2015 P13

5 **(a)** – Memory card / SSD / HDD / magnetic tape
– Suitable description of device given

(b) 2 hours = 120 minutes
120 × 180 = 21 600
21 600 / 1024 (or 21 600 / 1000)
= **21.1 GB (or 21.6 GB)**

(1 mark for correct answer and 1 mark for correct calculation)

9 **(a)** 8 MB
100

(b) **(i)** Any **two** from:
– removes sounds human ear can't hear very well
– if two sounds played at same time, softer sound removed
– uses perceptual music shaping

(ii) Lossy

(iii) **One** from, for example:
– jpeg
– MP4
– zip
– gif

Q 5) Winter 2015 P11

(b) Any **two** from:
– Blu-ray discs use blue/violet lasers rather than red lasers as used by DVDs
– storage capacity of Blu-ray discs is much higher than standard DVDs
– Blu-ray discs use one polycarbonate layer; DVDs use two layers
– Blu-ray discs have a built-in secure encryption system
[2]

(c) Any **two** from:
– DVD has one spiral track; DVD-RAM has several concentric tracks
– DVD-RAM can be written to and read from at the same time; DVD-R only allows the read operation to occur
– DVD-R only allows data to be read (can't write to it) whereas DVD-RAM allows reading and writing operation
[2]

7 **(a)** Lossy
– when decompressed, some detail is lost and file is not exactly like the original (but difference is usually not noticeable)

Lossless
– when decompressed the original file is restored with no loss of data

(b) 1 mark for type of file + 1 mark for description
e.g:

– JPG
– Used to store images/pictures

– MP3
– Used to store audio/sound files

(c) Any **three** from:
– company calculation is based on 1 GByte = 1000 MByte
– so (500 × 1000)/8 = 62 500 files
– customer calculation based on 1 GByte = 1024 MByte
– so (500 × 1024)/8 = 64 000 files
– giving the difference of 1500 files

9 **(a)** Any **one** from:
– verification is being described
– validation is when data follows a set of rules, e.g. length/range/type check

(b) Any **one** from:
– send as JPEG files
– carry out a file compression first

Q 6) Summer 2016 P11 & P13

11 (a) 1 mark for each correct row

	Single track	Many concentric tracks	Blue laser used to read/ write data	Red laser used to read/ write data	
DVD-RW	✓			✓	1 mark
DVD-RAM		✓		✓	1 mark
CD-ROM	✓			✓	1 mark
Blu-ray disc	✓		✓		1 mark

(b) (i) Any **three** from:

- don't need to "get up to speed" to work properly/no latency
- lower/less power consumption/more energy efficient
- run cooler
- run quieter
- data access is faster
- occupies less physical space/more compact
- lighter, so more suitable for a portable computer/laptop
- no moving parts so more reliable/durable in a portable computer/laptop

(ii) Any **two** from:

- HDD is cheaper for larger amounts of storage space
- HDD has greater longevity for read/write functions
- Expensive to change the technology // HDD are trusted technology
- No requirement for the increased speed of SSD

Q 7) Summer 2016 P12

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2016	0478	12

4 (a) Any **three** from:

- The file can be compressed
- The compression that is used is lossless (not lossy)
- use of a compression algorithm
- repeated words can be indexed
- repeated word sections (e.g. "OU") can be replaced by a numerical value
- reference to zip files
- save file as a pdf/convert to pdf [3]

(b) Any **four** from:

- the checksum for the bytes is calculated
- this value is then transmitted with the block of data
- at the receiving end, the checksum is re-calculated from the block of data received
- the calculated value is then compared to the checksum transmitted
- if they are the same value, then the data was transmitted without any error
- if the values are different, then an error has been found
- if the values are different, then a request is sent for the data to be re-transmitted [4]

10 1 mark for each correct storage device

ROM (not EPROM/PROM)
Blu-ray disc
RAM
DVD/ DVD-R(+R)/ DVD-RW(+RW)/ DVD-ROM (not CD or DVD-RAM)
SSD/example of a USB storage device
DVD-RAM

[6]

Q 8) Winter 2016 P12

8

Statement	TRUE or FALSE
MIDI stores the actual music notes in a compressed format	FALSE
JPEG files are examples of lossless file compression	FALSE
MP3 files are, on average, 90% smaller than the music files stored on a CD	TRUE
MP4 files are examples of lossy file compression	TRUE

[4]

Q 9) Winter 2016 P11& 13

(b) 2 marks for working + 1 mark for correct answer

Working
- 1200 × 8 = 9600 (bytes)
- 9600/1024 or 9600/1000

Answer
- 9.4 or 9.6 kilobytes

[3]

Q 10) March 2017 India

Question	Answer	Marks
7	High definition video – lossy (algorithm) – images may contain less detail without noticeable degradation in quality Text – lossless (algorithm) – so that the original and the decompressed text will be exactly the same	4

Question	Answer	Marks
13(a)	Primary storage – main memory inside a computer /directly accessed by CPU Example – ROM / RAM Secondary storage – non-volatile/persistant memory that is accessed by a device that is part of a computer system / not directly accessed by the CPU Example – HDD / SSD Off-line storage – non-volatile memory that can be removed from a computer system Example – DVD/ Blu-ray / CD / USB flash memory / removable or external HDD or SSD	6
13(b)	∞ 125 megabytes ∞ CD / low capacity flash memory ∞ good for mailing / inexpensive to buy	3

Q 11) Summer 2017 P11

Question	Answer	Marks
3	1 mark per correct tick	4

Statement	true (✓)	false (✓)
47KB is larger than 10MB.		✓
250bytes is smaller than 0.5MB.	✓	
50GB is larger than 100MB.	✓	
1TB is smaller than 4GB.		✓

Question	Answer	Marks
8	∞ Secondary ∞ HDD/SSD ∞ SSD/HDD ∞ Primary ∞ ROM/RAM ∞ RAM/ROM	6

Q 12) Summer 2017 P12

Question	Answer	Marks
2	2 marks for each type of storage **Primary storage** ∞ RAM ∞ ROM **Secondary storage** ∞ hard disk drive (HDD) ∞ solid state drive (SSD) **Off-line storage e.g.** ∞ CD ∞ DVD ∞ Blu-ray ∞ Flash memory // USB storage ∞ removable / external / portable hard disk drive (HDD/SSD) ∞ SD card	6

Q 13) Winter 2017 P12

2	1 mark for each correct category: *HDD* – Secondary *RAM* – Primary *ROM* – Primary *CD-ROM* – Off-line *SSD* – Secondary *DVD-RAM* – Off-line	6
8(a)	1 mark for correct calculation method, 1 mark for correct answer: ∞ 2048/1024 (or 1024 × 2) ∞ 2 GB	2
8(b)	∝ Instructions/programs/data ∞ … currently in use	2
8(c)	Any **three** from: ∞ RAM is volatile, ROM is non-volatile ∞ RAM is temporary, ROM is (semi) permanent ∞ RAM normally has a larger capacity than ROM ∞ RAM can be edited ROM cannot be edited // Data can be read from and written to RAM, ROM can only be read from.	3

Q 14) Winter 2017 P13

Question	Answer	Marks
2	1 mark for each correct file format e.g.	3

File type	File format
Pictures	.JPEG
Text	.doc, .txt, .rtf, .docx, .odt .pdf
Sound	.mp3, .wav, .aif, .flac, .mid
Video	.mp4, .flv, .wmv

Question	Answer	Marks
9(a)	Any **four** from: – (Red) laser is used – (Laser beams) shines onto surface of the disk – It is rotated (at a constant speed) to be read – Surface is covered in a track (that spirals from the centre) – Data is represented on the surface using pits and lands – Pits and lands represent binary values – Pits reflect light back differently (to the area in between/land) – Optical device can determine the binary value from the light reflection	**4**
9(b)	1 mark for calculation, 1 mark for correct answer: – 1000 · 16 – 16000/8 – Answer is **2000** bytes	**2**
9(c)	**Four** from: (Max 2 for either primary or secondary) – Primary RAM and ROM – Secondary HDD and SSD – Primary is directly accessible by CPU – Secondary is not directly accessible by CPU – Primary is internal to computer – Secondary can be internal **or** external to the computer – Primary stores boot up instructions **and** can hold data whilst being processed – Secondary stores files/software – Primary has faster access speed – Secondary has a slower access speed – Primary has both volatile **and** non-volatile – Secondary is non-volatile	**4**

Q 15) March 2018 P12 (India)

Question	Answer	Marks
6	1 mark for suitable example and 1 mark for suitable associated use. Primary RAM … … stores OS when running / data currently in use / instructions currently in use ROM … … stores boot instructions / BIOS Cache … … stores frequently used instructions Secondary HDD / SSD… …stores files / applications (by example) Offline CD/DVD/Blu-ray/Flash Memory/USB stick/Removable HDD/Removable SSD… … stores files / applications (by example)	**6**

Question	Answer	Marks
9	Max 3 – 1 mark for correct answer and 2 marks for correct calculations. Any **two** from: 16000 · 32 512000 / 1024 Or 16000 · 8 128000 · 32 4096000 / 8 512000 / 1024 **Correct answer:** 500 kB	**3**

Q 16) Summer 2018 P11

8(d)	Secondary Storage – any **two** from: – Not directly accessed by the CPU – Non-volatile storage – Secondary is internal to the computer/device – An example of secondary storage would be HDD/SSD Off-line storage – any **two** from: – Non-volatile storage – Off-line storage is storage that is removable from a computer/device // not internal // portable – An example of off-line storage would be CD/DVD/USB stick/SD card/magnetic tape/ external HDD/SSD	**4**

Q 17) Summer 2018 P12

Question	Answer	Marks
1	1 mark for each unit, in the given order: – nibble – byte – megabyte (MB) – gigabyte (GB)	**4**

Q 18) Winter 2018 P12

Question	Answer	Marks
2(a)	1 mark for each correct tick (✓)	**3**
2(b)	Primary	**1**
2(c)	**Two** from: ∞ Non-volatile storage ∞ Storage that can be disconnected/removed from the computer ∞ Any suitable example ∞ Must be (physically) connected to computer to obtain stored data ∞ Used to store files as a backup	**2**

Statement	RAM (✓)	ROM (✓)
Stores the programs and data that are currently in use	✓	
Used to boot up the computer when power is turned on		✓
Contents are retained when power is turned off		✓

Q 19) Winter 2018 P13

Question	Answer	Marks
3	**Six** from: ∞ A pressure sensor is used ∞ The sensor sends data/signals to the microprocessor ∞ Data is converted to digital format ∞ Microprocessor compares data value against set **value** ∞ If value <= 2400 Kg/under weight limit lift is permitted to operate ∞ If value > 2400 Kg/over weight limit **signal is sent from the microprocessor** to deliver warning message to passengers ∞ If value > 2400 Kg **signal is sent from the microprocessor** to lift mechanism to stop lift operating ∞ Weight continuously monitored	**6**

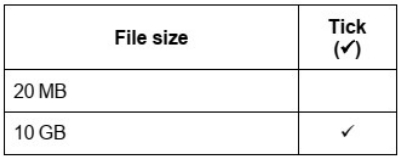
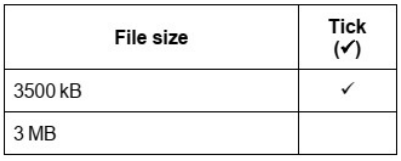
Question	Answer	Marks
9	**Four** from: ∞ ROM is permanent … ∞ … RAM is temporary ∞ ROM is non-volatile ∞ … RAM is volatile … ∞ ROM is read only … ∞ … RAM can have read/write operations ∞ ROM holds instructions for boot up … ∞ … RAM holds files / instructions **in use**	**4**

Question	Answer	Marks
12	**Four from (**Max three from each): **MP3** ∞ Digital recording of sound ∞ Produced by recording software / microphone ∞ Used when distributing sound files ∞ Compressed file format **MIDI** ∞ Instructions of how to make sound ∞ Non-audio recording ∞ File created using **digital** musical instruments ∞ Produced by synthesizer ∞ Used when composing music ∞ Individual notes/instruments can be changed	**4**

Question	Answer	Marks
13(a)	1 mark for storage, 1 mark for justification ∞ External/Removable HDD // External/Removable SSD // Large capacity USB Flash Drive ∞ Backups must be stored separately ∞ Will hold sufficient data ∞ Faster write abilities (SSD/USB drive only)	**2**

Question	Answer	Marks
13(b)	1 mark for storage, 1 mark for justification ∞ SSD // SD card // Flash memory ∞ Small physical size ∞ Lightweight ∞ Low heat production ∞ Low power consumption ∞ It's quiet ∞ Fast read/write times	**2**
13(c)	1 mark for storage, 1 mark for justification ∞ DVD // Blu-ray // USB Flash Drive // SD card ∞ Easy to distribute ∞ Small in size ∞ Cheap to buy ∞ Universal storage therefore compatible with many devices	**2**

Q 20) March 2019 P12

1(a)	 	**1**
1(b)	 	**1**

4(c)	– Lossy would remove data – Lossless does not remove data // No data can be lost … – Can be restored to original state … – … otherwise will not run / work correctly	4
6(c)(i)	1 mark per each correct tick	5

Storage example	Primary	Secondary	Off-line
Solid state drive (SSD)		✓	
Blu-ray disc			✓
USB flash memory			✓
Random access memory (RAM)	✓		
Read only memory (ROM)	✓		

6(c)(ii)	**Six** from: – Storage device has platters – Platters/disk divided into tracks – Storage platter / disk is spun – Has a read/write arm that moves across storage media – Read/writes data using electromagnets – Uses magnetic fields to control magnetic dots of data – Magnetic field determines binary value NOTE: Marks can be awarded for an alternative description e.g. magnetic tape	6
6(c)(iii)	– Magnetic is cheaper **per unit of data** – Magnetic has more longevity // Magnetic can perform more read/write cycles	2

Q 21) Summer 2019 P11

5	**Five** from:
	• A (compression) algorithm is used
	• No data is removed in the process // original file can be restored
	• **Repeated** words (are identified) // **Patterns** in the data (are identified)
	• … and are indexed/put into a table // by example
	• … and are replaced with their index // by example
	• … and their positions are stored (in the table) // by example
	• … and the number of times the word/pattern appears is stored (in the table) // by example
	
	NOTE: Other valid methods of lossless compression can be awarded marks
		5

6(b)	**Four** from (max 3 marks for benefits only, without an explanation): • More read/write cycles (over its lifetime) // greater longevity … • … likely to be a lot of read/write functions each day • Read/write speed is sufficient … • … even though it is slower than solid-state • Cheaper **per unit of data** stored … • … better value for the company to purchase • … so the law company can afford to buy a server with greater storage capacity • No requirement for portability … • … as a server, it does not need to be moved • Trusted technology … • … it has been traditionally used for many years	4
6(c)	• DVD • CD • Blu-ray	3

Q 22) Summer 2019 P12

2(a)	**Two** from: – It is non-volatile – Can be easily disconnected from the computer – It is not directly accessed by the CPU – Suitable example e.g. CD, DVD, USB flash memory	**2**
2(b)(i)	**One** from: – ROM – RAM	**1**
2(b)(ii)	**Two** from: – HDD – SSD – Flash memory	**2**
4(a)	**Two** from e.g.: – DVD uses red **laser**/light whereas blu-ray uses **blue**/violet laser/light – DVD has a **smaller** (storage) capacity // Blu-ray has a **larger** (storage) capacity – DVD has **two layers** (of polycarbonate) whereas Blu-ray disks have a **single layer** (of polycarbonate) – DVD has a **slower transfer** rate (of approximately 10 mbps) // Blu-ray has a **faster transfer** rate (of approximately 36 mbps)	**2**
4(b)(i)	2 marks for any two correct stages of working, 1 mark for correct answer. – 500 * 300 * 10 // 150 000 *10 – * 8 then ÷ 8 (anywhere in the process) – 1 500 000 ÷ 1024 ÷ 1024 // 1 500 000 ÷ 1 048 576 – = 1.43 MB	**3**
4(b)(ii)	**Four** from: – **Rollers** are used to move the paper through the printer – **Nozzles** spray/drop/jet ink onto the paper – Ink jets/print head/nozzles are moved across the paper (to distribute the ink) – Different colour inks are mixed to create required colours – Technology could be piezoelectric – Technology could be thermal bubble – **Ink** is heated – … and expands/evaporates into a bubble – Bubble is pushed through the nozzle on to the paper – … then the bubble collapses – Electrical current is applied to a crystal – … which makes it vibrate – … which forces a droplet of ink through the nozzle	**4**
7(b)	**Three** from: – Read only memory – Non-volatile memory // Contents of memory are retained when power is turned off//permanent storage – Primary storage // directly accessed by the CPU – Holds firmware/boot-up instructions/start-up instructions/BIOS – Cannot be written to	**3**

Q 23) Winter 2019 P13

1(a)(ii)	**Two** from: ∞ HDD ∞ SSD ∞ USB flash memory drive ∞ SD card ∞ Any optical	**2**
7(a)(i)	**Three** from: ∞ RAM ∞ Primary memory ∞ Volatile memory ∞ Holds currently in use data/instructions ∞ Directly accessed by the CPU	**3**

Q 24) Winter 2019 P12

Question	Answer	Marks
1	**One** mark for each correct tick Statement / True (✔) / False (✔) 25 kB is larger than 100 MB /	✓ 999 MB is larger than 50 GB /	✓ 3500 kB is smaller than 2 GB / ✓ / 2350 bytes is smaller than 2 kB /	✓	4

Question	Answer	Marks
5(a)	**Four** from: ∞ A compression algorithm is used ∞ Discards any unnecessary sounds … ∞ … using perceptual musical shaping ∞ … such as removing background noise / sounds humans can't hear // or other suitable example ∞ Reduces sample size / resolution // by example ∞ Reduces sample rate // by example ∞ Sound is clipped ∞ The data is permanently removed	4
5(b)(i)	**One** from: ∞ The file size will be smaller than lossless ∞ Requires less storage space ∞ Requires less time to transmit	1
5(b)(ii)	**One** from: ∞ The quality of the sound will be reduced ∞ The original file cannot be restored	1

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Question	Answer	Marks
5(c)(i)	**Four** from: ∞ Musical Instrument Digital Interface file ∞ Stores a set of commands / instructions for how the sound should be played ∞ Does not store the actual sounds ∞ Data in the file has been recorded using digital instruments ∞ Specifies pitch of the note // specifies the note to be played ∞ Specifies when each note plays and stops playing // Specifies key on/off ∞ Specifies duration of the note ∞ Specifies volume of the note ∞ Specifies the tempo ∞ Specifies the type of instrument	4
5(c)(ii)	**Four** from: ∞ It uses a single wire … ∞ … therefore, it is cheaper to manufacture / buy / install ∞ … therefore, less likely to have interference // no crosstalk ∞ … therefore, can be used over longer distances ∞ Data is sent a bit at a time … ∞ … therefore, less chance of data being skewed // data is received in order ∞ Transmission can be synchronised … ∞ … can reduce rate of errors	4

Question	Answer	Marks
11(a)	**RAM** ∞ To store the data / instructions / parts of OS that are currently in use **ROM** ∞ To store the firmware / bootup instructions / BIOS **SSD** ∞ To store files / software // by example	3
11(b)	**Two** from: ∞ It is more durable // it has no moving parts ∞ It has a faster read / write / access speed ∞ It is more compact / light weight / smaller / portable ∞ It uses less energy // battery will last longer ∞ It is quieter ∞ Not affected by magnetic forces ∞ It runs at a cooler temperature ∞ Less latency // takes less time to warm up	2

Q 25) March 20 P12

Question	Answer	Mark
3(a)(i)	Any **one** from: • They are both non-volatile • They are both secondary storage // Both not directly accessed by the CPU • They both have a high capacity of storage • Both have read **and** write abilities	1
3(a)(ii)	Any **three** from: • HDD has moving parts but SSD does not • HDD uses magnetic storage whereas SSD uses flash memory • HDD is slower to **access data** than SSD // HDD has greater latency than SSD • HDD will create noise/heat, whereas SSD runs quieter/cooler • HDD has higher power consumption than SSD • HDD have greater longevity/more read-write cycles whereas SDD has lower longevity/limited number of read-write cycles • HDD larger in physical size/heavier than SSD • HDD is normally cheaper for the same capacity of storage as SSD • HDD is available in a larger storage capacity than SSD	3
3(b)	Any **one** from: • USB flash memory drive • **External** HDD/SSD • SD Card • CD / DVD / Blu-ray	1
3(c)(i)	Any **two** from: • Keyboard • Mouse • Microphone • Touchscreen	2
3(c)(ii)	Any **two** from: • Monitor / Screen • Speakers • Headphones • Printer	2

Question	Answer	Mark
3(d)	Any **two** from: • Uses a compression algorithm • Does not **permanently** remove any data • Repeated patterns of notes are identified … • … and are grouped, with an index NOTE: Other possible methods of lossless compression of sound can be credited	**2**
3(e)(i)	Any **two** from: • Stores the notes played and not the sound • Contains instructions/commands for digital instruments // Is recorded / played on a digital instrument e.g. synthesiser • Stores data about notes e.g. pitch byte (Note: Two examples can be awarded) • Can be a compressed format • Can edit **individual notes**	**2**
3(e)(ii)	Any **two** from: • Contains actual **sound** • Contains samples of the sound wave • Contains metadata // by example • Uses lossy compression • Recorded using microphone // Is recorded/played on an MP3 recorder/player	**2**

Q 26) Summer 20 P12

Question	Answer	Marks
9(a)		**6**

Statement	HDD (✓)	SSD (✓)
It has a limited number of read/write cycles		✓
It uses magnetic properties to store data	✓	
It has moving parts	✓	
It is non-volatile storage	✓	✓
It can be used as an external storage device to back-up data	✓	✓
It uses flash memory to store data		✓

Question	Answer	Marks
9(b)	Any **two** from: – CD (drive) – DVD (drive) – Blu-ray (drive)	**2**

Q 27) 15a Summer 20 P11

1(d)	– It needs RAM to store the data and programs currently in use – It needs ROM to permanently store the boot up instructions	**2**
3(c)	– A compression algorithm is used – No data is removed in the compression process – An index/dictionary of pixels is created – The number of times a pixel is repeated in a row is stored	**4**

Q 28) Winter 20 P12

1(c)(ii)	**One** from: – Lossy (compression) Any **three** from: – A (compression) algorithm is used – Removes redundant/unnecessary data from the file – Removes sounds that cannot be heard by the human ear/background noise – Reduces sample rate – Reduces sample resolution – Data is **permanently** removed // original file cannot be re-instated – Perceptual music shaping is used NOTE: If lossless given, marks can be awarded for a correct description of lossless as follow through. Any **three** from (lossless): – A (compression) algorithm is used – Repeating patterns are identified – … are replaced with a value – … and indexed – No data is permanently removed // original file can be re-instated – Suitable example of a lossless algorithm	**4**
1(c)(iii)	Any **two** from: – Quicker for her to upload – Quicker for users to download – Won't slow website down as much when loading – Takes up less **storage** space	**2**
3(b)	Max **three** from: – Solid state drive – Non-volatile – Secondary storage – Flash memory – Has no mechanical/moving parts – Uses transistors – … and cells that are laid out in a grid – Uses control gates and floating gates – Can be NAND/NOR (technology) – Use EEPROM technology Max **two** from: – Stores data by flashing it onto the chips – Data stored by controlling the flow of electrons **through/using transistors/chips/gates** – The electric current reaches the control gate and flows through to the floating gate to be stored – When data is stored the transistor is converted from 1 to 0	**4**
3(c)	**One** mark for each correct row:	**6**

Statement	Blu-ray (✓)	CD (✓)	DVD (✓)
A type of optical storage	✓	✓	✓
Has the largest storage capacity	✓		
Can be dual layer	✓		✓
Read using a red laser		✓	✓
Has the smallest storage capacity		✓	
Stores data in a spiral track	✓	✓	✓

Q 29) Winter 20 P13

1	**One** mark for each correct row: **Device** / **Input (✓)** / **Output (✓)** / **Storage (✓)** Solid state drive (SSD) / / / ✓ Headphones / / ✓ / 2D cutter / / ✓ / LCD projector / / ✓ / Microphone / ✓ / /	5
9(a)	Any **three** from: – Both need a **red** laser to read/write data – Both are spun to be read – Both use spiral tracks for data – Both are optical storage – Both are off-line storage // both non-volatile – Both use pits and lands to store data	3
9(b)	Any **one** from: – DVD can be dual layer, but CD can only be single – DVD has higher storage capacity – DVD has a shorter wavelength laser – DVD are spun faster – DVDs have a higher data transfer rate	1

Q 30) March 21 P12

1(c)	– 11	**1**
2(a)	Any **three** from: – A compression algorithm is used – Data will be lost/deleted **permanently** // original file cannot be recreated – Reduce the range of colours used / colour depth / bits per pixel – Reduce the number of pixels / image resolution removes data that will not be noticed by the user // removes unnecessary data	**3**
4(b)(i)	Max **three** from: – Flash storage – Uses transistors/controls gates/floating gates – Can be NAND/NOR technology // Can use flip-flops – Stores data by flashing it onto the chips/device – Controlling/using the flow of electrons through/using transistors/chips/gates – The electric current reaches the control gate and flows through to the floating gate to be stored – When data is stored the transistor is converted from 1 to 0 / 0 to 1	**3**
4(b)(ii)	Max **one** from: – Faster read/write operation – Produces less heat // needs less cooling – Less susceptible to interference/magnets – Less power consumption	**1**