Cambridge (CIE) IGCSE ICT

Components of Computer Systems

Contents

* Central Processing Unit (CPU)
* Internal Memory
* Input Devices
* Output Devices
* Storage

CPU

What is the purpose of the CPU?

- The purpose of the Central Processing Unit (CPU) is to **fetch**, **decode** and **execute** instructions

- The CPU is the brain of the computer and its job is to take an input, process data and produce an output

What is the Fetch-Execute cycle?

- The **Fetch-Execute Cycle** is the cycle that the central processing unit (CPU) runs through billions of times per second to make a computer work

- The CPU is made up of 4 key components

  - **Arithmetic Logic Unit (ALU)**

  - **Control Unit (CU)**

  - **Cache**

  - **Registers**

- A computer takes an input, processes the input and then delivers an output for the user

  - **Input:** Clicking a button on the gamepad

  - **Process:** The CPU inside the console follows a set of instructions to carry out the task

  - **Output:** The player moving on screen
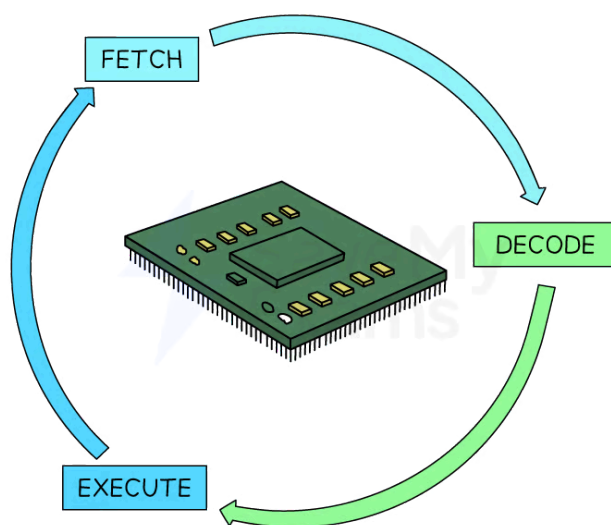
The Fetch-Execute cycle stages

Fetch stage

- During the fetch stage of the cycle, the next instruction or data must be fetched from the computer's memory (**RAM**)

- The instruction or data is brought back to the CPU

Decode stage

- During the decode stage of the cycle, the CPU needs to work out what is required from the instruction

- This could be a range of tasks depending on what the instruction or data included

Execute stage

- During the execute stage of the cycle, the CPU will carry out the instruction that was fetched

- Some examples that would take place at this stage are

  - **Performing a calculation**

  - **Storing a result or data back in main memory (RAM)**

  - **Going to main memory to fetch data from a different location**

RAM

What is RAM?

- RAM (Random Access Memory) is **primary storage** that is directly connected to the CPU and holds the **data** and **instructions** that are currently in use (**temporary**)

- RAM is **volatile** which means the contents of RAM are lost when the power is turned off

- For the CPU to access the data and instructions they must be **copied from secondary storage**

- RAM is **very fast** working memory, much faster than secondary storage

- RAM is **read/write** which means data can be read from and written to

- In comparison to ROM, it has a much **larger capacity**

- RAM capacity **can be increased** to improve performance

ROM

What is ROM?

- ROM (Read Only Memory) is **primary storage** that holds the **first instructions** a computer needs to **start up** (Boot file)

- ROM contains the **BIOS** (Basic Input Output System)

- ROM is a small **memory chip** located on the computers **motherboard**

- ROM is **fast** memory, much faster than secondary storage but **slower than RAM**

- ROM is **non-volatile** which means the contents of ROM are not lost when the power is turned off

- ROM is **read only** which means data can only be read from

- In comparison to RAM, it has a much **smaller capacity**

- ROM capacity **can not be increased**

Differences between RAM & ROM

Feature	RAM	ROM
Stores	Data & programs in use	Boot file (start-up instructions)
Capacity	Variable	Fixed

Contents	Temporary	Permanent
Read/Write	Read & write	Read only
Volatile/Non-volatile	Volatile	Non-volatile

Worked Example

State **two** characteristics of RAM

[2]

Answer

Two of:

RAM can be read from and written to [1]

RAM is volatile memory [1]

RAM is temporary storage [1]

Input Devices

What is an Input Device?

- Input devices are **hardware components** that **allow users to interact** with a computer system

- They enable the user to **input data or commands into the system**, which the computer then processes to produce an output

Types of input devices

Input device	Advantages	Disadvantages
Keyboard (Entering data into a computer)	- Easy method of entering data - Very common	- Repetitive strain injury - Slow to enter data compared to direct data entry
Numeric **Keypad** (**ATMs**, chip and PIN devices)	- Fast - Easy to use	- Size of buttons can impede some users - Button layouts not always the same
Pointing Devices (**Mouse**)	- Intuitive and precise control - Fast to make on-screen choices	- RSI (strain on wrist) - Requires flat surface - People with disabilities can find them difficult to use
Remote Control (TV, hi-fi remotes)	- Easy to use - Can control from a distance	- May require line-of-sight - Easily lost - Needs regular battery replacements

Pointing Devices (**Joystick/Driving Wheel**)	▪ Enhances gameplay/simulation experience ▪ Improve realism ▪ Accurate	▪ Expensive ▪ Limited use outside of gaming and simulators
Touchscreen (Smart phones & tablets)	▪ Intuitive ▪ No need for a separate pointing device ▪ Easy to keep clean	▪ Screens can get dirty ▪ Easily scratched ▪ Less precise than a mouse
Scanner (Convert paper documents to electronic)	▪ Accurate reproduction ▪ Easy to share and store ▪ Combined with barcodes becomes a DDE	▪ Quality depends on resolution ▪ High quality means can be slow
Digital camera (Taking photos/videos)	▪ Vast amounts can be captured ▪ No developing ▪ Easy to share	▪ Storage compression can lead to a loss in quality ▪ Need to be tech-savvy to use effectively
Microphone (Input speech, sensor to pick up sounds)	▪ Hands-free input ▪ Can be used for voice recognition ▪ Fast	▪ Variable quality ▪ Verbal inputs can be inaccurate ▪ Need to remember key words/phrases
Analogue **sensors** (Measure environmental data e.g. temperature, light, sound, humidity etc.)	▪ Generally accurate ▪ Provides real-time information ▪ Automatic ▪ Can collect data from places where they may be threat to human life	▪ May require calibration ▪ Data must be converted to digital data (ADC) ▪ Data may need to be checked for accuracy
Light pen	▪ Accuracy for fine detail	▪ Lag

(Select/write on screen)	▪ Small & lightweight ▪ Easy to use	▪ Only work on certain types of screen ▪ Dated technology

Worked Example

A house contains a microprocessor-controlled central heating system.

Identify two input devices that would be used in this system.

[2]

Answer

Two from:

- Keypad
- Temperature sensor
- Override switch for timing
- Touch screen
- Remote control//smartphone//tablet

Direct Data Entry

What is a direct data entry device?

- A direct data entry device is a device capable of inputting data into a computer with little/no human interaction

- Data collection and transfer is completed automatically

Types of direct data entry devices

Direct data entry device	Advantages	Disadvantages
Magnetic stripe reader (Debit/credit cards)	▪ Fast ▪ Simple to use ▪ Secure (unreadable)	▪ Magnetic stripes can get damaged and become unreadable ▪ Reader must be in close contact
Chip and PIN reader	▪ Secure ▪ Reduced fraud risk	▪ Requires PIN input ▪ Potential for skimming ▪ High payment limits an issue for stolen cards

RFID reader (read only) (Contactless payment)	■ Fast transaction (no pin) ■ Data wirelessly transferred securely ■ Retailers don't have to access customer credit/debit information	■ Transaction limit is smaller ■ RFID signals can be read/intercepted
RFID reader (Security tags on clothes, location tracking)	■ Very fast ■ Data can be sent both ways ■ Bulk detection	■ Radio waves can be blocked/jammed ■ Tag collisions ■ Possible to hack
Optical Mark Recognition (**OMR**, read marks on exam paper in pen/pencil)	■ Fast processing ■ Reduced human error	■ Limited to specific forms ■ Cannot read handwriting ■ Form must be completed accurately
Optical Character Recognition (**OCR**, text to digital data)	■ Fast data entry ■ Accurate and less error prone	■ Can struggle with complex layouts ■ Font dependent ■ Not always 100% accurate ■ Expensive
Barcode reader (reads barcode labels)	■ Fast and accurate ■ Low cost ■ Allows for automatic stock control ■ Tried & trusted	■ Requires line-of-sight ■ Barcodes are easily damaged ■ Barcodes can be swapped/altered by consumers
QR scanner (QR codes)	■ Can store more data than barcodes ■ Versatile uses ■ Easy to read ■ Can be encrypted	■ QR codes can store malicious code ■ Different QR code formats

Your notes

Save My Exams

Worked Example

For each of the following uses of data capture, name **one** appropriate direct data entry device. The devices must be different in each case

a. Contactless credit cards **[1]**

Radio Frequency Identification/RFID reader [1]

b. Multiple choice answers in an examination paper **[1]**

Optical Mark Reader/OMR [1]

c. To scan items at a computerised till **[1]**

Bar Code reader/scanner [1]

Output Devices

What is an output device?

- Output devices are hardware components that **receive information from a computer system** and **present it to the user** in a comprehensible form

- They enable the computer to **communicate the results** of processed data or commands

Types of output devices

Output device	Advantages	Disadvantages
Monitor (**CRT**)	■ Large viewing angles ■ Can be used with light pens	■ Run hot ■ Heavy ■ Consume more power (than other monitor types)
Monitor (**LCD**)	■ Low power ■ Lightweight ■ No flickering ■ No image burn-in	■ Motion blur/ghosting ■ Colour & contrast variable from different viewing angles
Monitor (**LED**)	■ No motion blur/ghosting ■ Low power ■ Long life	■ More expensive (than LCD) ■ Contrast can be poor
Touch screen (Output)	■ Intuitive ■ Space-saving	■ Susceptible to smudge ■ Potential calibration issues
Multimedia projector (Output computer usually to much larger display)	■ Large display ■ Good for presentations ■ Space saving	■ Requires darkened room ■ Expensive bulbs ■ Need separate audio ■ Quality is variable

Laser printer (Dry ink)	▪ Fast ▪ High-quality prints ▪ Lower cost per page	▪ Expensive initial cost ▪ Limited to flat surfaces
Inkjet printer (Four/five wet inks)	▪ Lower initial cost ▪ High-quality prints ▪ Ink can be refilled	▪ Slower ▪ Higher cost per page ▪ Ink may smudge
Dot matrix printer (Inked ribbon)	▪ Low cost ▪ Can print multi-part forms ▪ Very good for long print runs	▪ Noisy ▪ Low print quality ▪ Slow
Plotters (Drawing & blueprints)	▪ High accuracy ▪ Can print on various materials ▪ Inexpensive to run	▪ Slow ▪ Expensive to buy ▪ Large size
3D printer	▪ Customisable designs ▪ Rapid prototyping ▪ Medical benefits	▪ Limited materials ▪ Slow process ▪ Counterfeit items easier to produce ▪ Very expensive
Speakers	▪ Range of sizes and power outputs ▪ Immersive audio ▪ Helps people with disabilities	▪ Expensive for higher quality output ▪ Varying sound quality
Actuators (Control motors, pumps, switches etc.)	▪ Precise movement ▪ Programmable ▪ Allow automatic control of many devices	▪ Requires power ▪ Potential mechanical wear ▪ Requires DAC interface

Worked Example

Complete the following sentences using the most appropriate items from the list below.

A 3D printer	An ADC	A compiler	An interpreter	A microphone
A monitor	A numeric keypad	A speaker	A switch	A USB

a. _____ is a device used to input a pin

[1]

A numeric keypad [1]

b. _____ analyses and executes a program line by line

[1]

An interpreter [1]

c. _____ produces output in the form of solid objects

[1]

A 3D printer [1]

d. _____ produces output in the form of sound

[1]

A speaker [1]

Storage Devices

What is a storage device?

- A storage device is **the hardware that reads from and writes to** different storage medias

- Storage devices are **non-volatile secondary storage**, that retain digital data within a computer system

- They provide a means of **storing**, **accessing**, and **retrieving data**, which can include software applications, documents, images, videos, and more

- There are 3 types of storage device:

    - **Magnetic**

    - **Solid State**

    - **Optical**

Examiner Tips and Tricks

- Another term used to describe a storage device is '**backing storage**'
- These terms are **interchangeable**
- Backing storage is any non-volatile storage device used to store data and programs when they are **not in use by the computer's main memory** (**RAM**)

Magnetic storage

- Magnetic storage is a type of non-volatile media that uses **magnets** (polarity) to store binary 0s and 1s

Advantages	Disadvantages
Capacity - High storage	**Durability** - Moving parts can get damaged if dropped
Cost - Low per gigabyte	**Portability** - Heavy & bulky making them less convenient for transport
Speed - Moderate read/write access	**Reliability** - Prone to mechanical failure
	Noise - Loud (spinning disks)

Solid state storage

- Solid state storage is a type of non-volatile media that uses **electronic circuits** to store binary 0s and 1s

Advantages	Disadvantages
Capacity – Medium/high storage	**Cost** – Very high per gigabyte
Speed – Very fast read/write access	**Reliability** – Limited read/write cycles
Durability – No moving parts	
Portability – Small and no moving parts	
Noise – Silent	

Optical storage

- Optical storage is a type of non-volatile media that uses **lasers** to burn the surface of a disk, creating pits and lands suitable for storing binary 0s and 1s

Advantages	Disadvantages
Cost – Very low per gigabyte	**Capacity** – Very low
Durability – No moving parts	**Speed** – Very slow read/write access
Portability – Small and no moving parts	**Reliability** – Prone to scratches
Noise – Silent	

Storage Media

What is storage media?

- Storage media is **the physical media that holds non-volatile data**

- Storage devices have a **specific read/write mechanism built in** to interact with a particular storage media

- For example, magnetic tape media is read by a magnetic storage device

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Examiner Tips and Tricks

Try not to get confused between storage devices and storage media.

Think of storage devices as large pieces of furniture in your home e.g. bookshelf, chest of drawers etc.

Storage media is what you store in the furniture e.g. books on the shelf or clothes in the drawers

Storage media all hold data, but the way it stores/accesses it can be very different, so just like you wouldn't store clothes on a bookshelf, you need to pair the correct storage device and storage media

Example storage media

Media	Use	Advantages	Disadvantages	Storage Devices
Hard disk drive (HDD)	General-purpose storage in computers and servers	Large storage capacity (5TB), relatively fast	Moving parts, vulnerable to physical damage	Magnetic
Portable hard disk drive	External storage for data transfer and backup	Portable (5TB), large storage capacity	Slower than SSDs, vulnerable to physical damage	Magnetic
Magnetic tape	Backup and archiving, especially for large volumes of data	High storage capacity (10TB), low cost	Slow access time, sequential access	Magnetic
CD	Audio and data storage, software distribution	Affordable, widely compatible	Low capacity (700MB), susceptible to scratches	Optical
DVD	Higher capacity storage for data, video, and software distribution	Higher capacity than CD (8.5GB), affordable	Susceptible to scratches, lower capacity than Blu-ray	Optical
Blu-ray	High-definition video and high capacity data storage	High capacity (50GB), high-resolution video storage	More expensive, and requires specific hardware	Optical
Solid state drive (SSD)	Fast internal storage for modern computers	Fast access time, no moving parts, high capacity (30TB)	More expensive, limited write cycles	Solid state

Portable solid state drive	External storage for fast data transfer and backup	Fast access time, portable, no moving parts, high capacity (2TB)	More expensive, limited write cycles	Solid state
USB memory stick	Portable data storage and transfer for various devices	Small size, fast read/write speeds, high capacity (1TB)	Limited capacity compared to other storage devices	Solid state
Flash memory (SD/XD)	Removable memory cards used in smartphones/digital cameras	Very small, durable, large capacities	Easy to lose due to size, expensive per GB compared to HDD	Solid state

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Worked Example

A program collects a large amount of data and this could be stored using either a fixed solid-state drive (SSD) or cloud storage.

a. Describe **four** advantages to the school of using cloud storage rather than using the SSD

[4]

Answer

Four of:

The cloud has greater storage capacity [1]

The data could be sent directly to/from the cloud from any computer/device [1]

Storage capacity can be increased without adding additional physical devices [1]

Many people can share the data [1]

The school would only pay for the storage used [1]

There is an automatic backup of data [1]

b. Describe **three** disadvantages to the school of using cloud storage rather than using the SSD

[3]

Answer

Three of:

More security issues as multiple copies of the data are stored [1]

The school loses control over the storage of the data [1]

Cloud storage has an ongoing cost [1]

Users must have a reliable internet connection to store data [1]

Users must have an internet connection to access data [1]