

Cambridge IGCSE

Computer Science

Section 3

Hardware

3.1 Computer Architecture (ii)

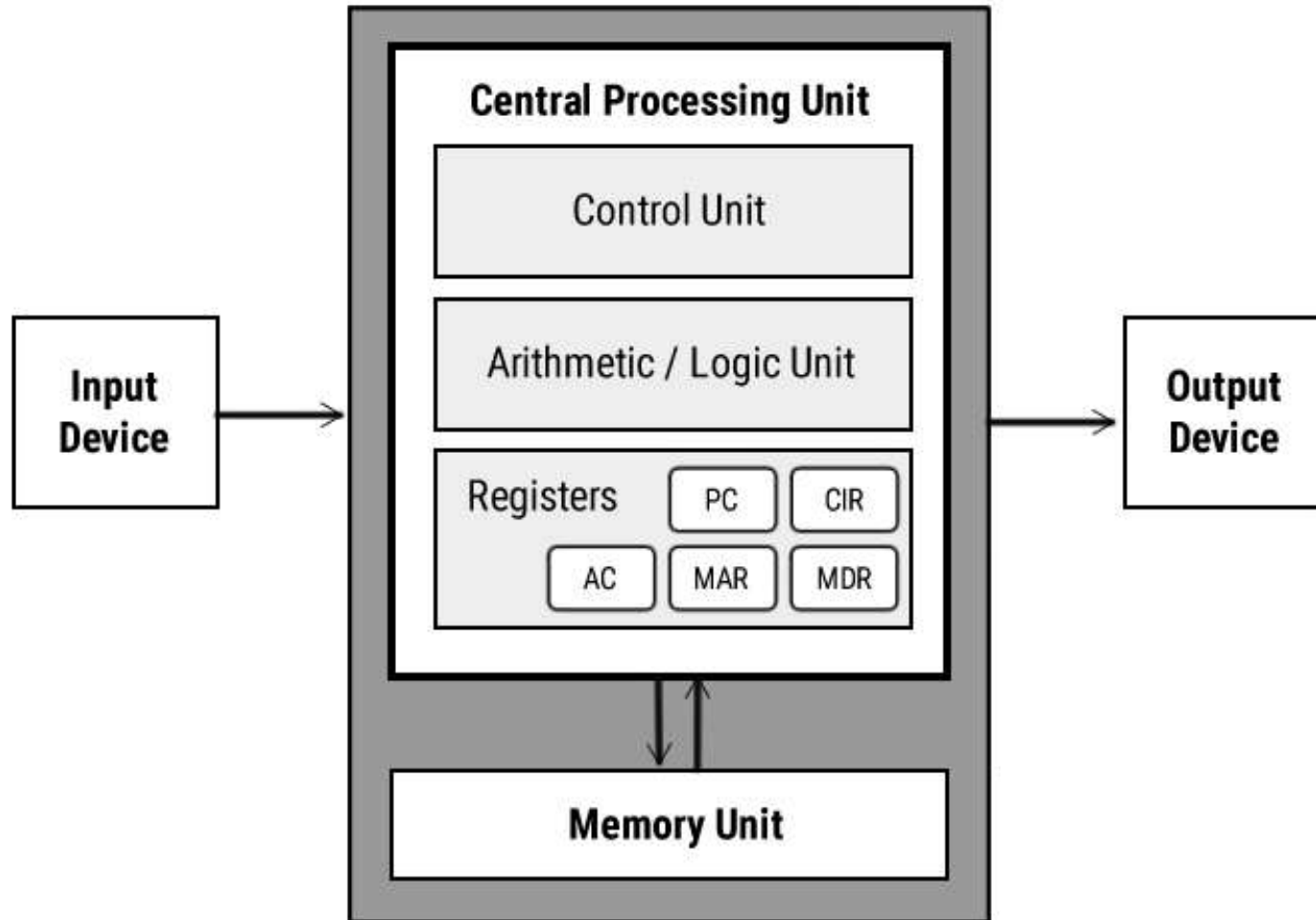
Objectives

- Understand what is meant by a core, cache and clock in a CPU and explain how they can affect the CPU performance
- Understand the purpose and use of an instruction set for a CPU

Vocabulary

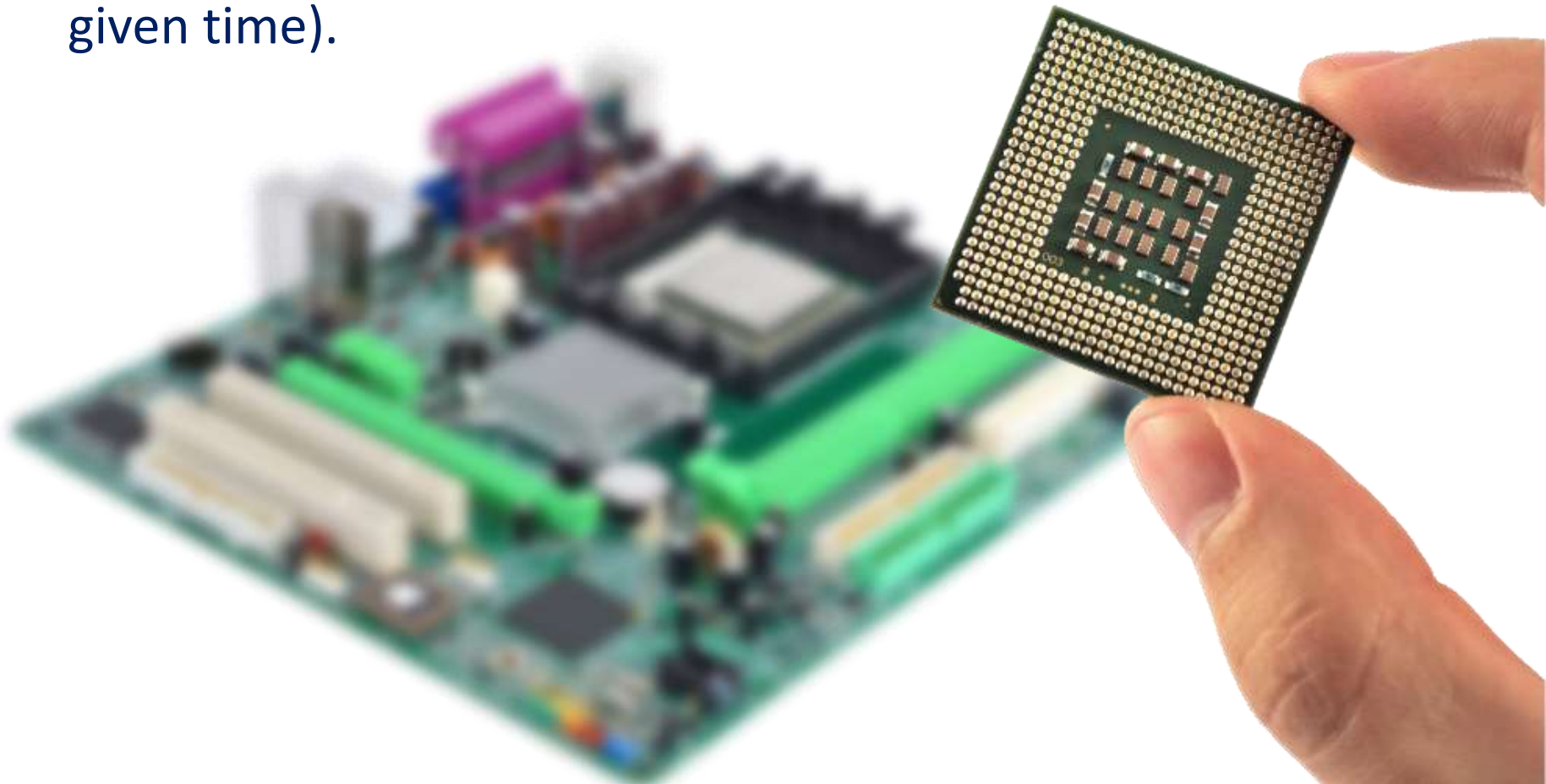
- core
- cache
- clock
- instruction set
- BIOS
- over-clocking
- RAM
- synchronise
- access time
- channel
- machine code
- opcode
- operand

CPU review



CPU performance

The speed of a computer is affected by how well the CPU is performing (how many instructions it can process in a given time).



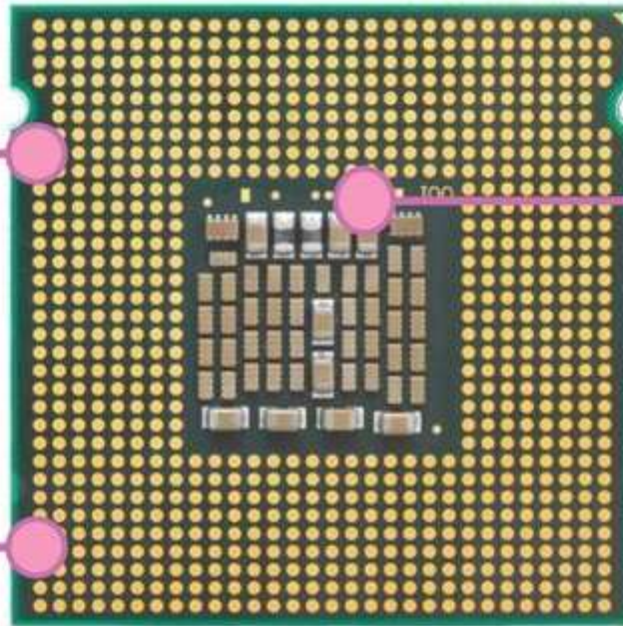
Factors that can affect CPU performance

Clock speed

Cycles per second
measured in hertz

Number of cores

The number of duplicate
CPUs on a single chip



Cache size

Superfast working
memory

Factors that can affect CPU performance

1 - Clock Speed

- The **system clock** defines the clock cycle that **synchronises** all computer operations.
- It is the **Control Bus** that transmits the timing signals that ensures that everything is **synchronised**.
- The **clock speed** indicates the **number of instructions processed by a CPU in a second**.
- It is usually measured in gigahertz (GHz).
- A **4GHz** processor processes **4,000,000,000 (4 billion) instructions per second!**

Factors that can affect CPU performance

1 - Clock Speed

One clock cycle per second = 1 Hertz (Hz)
= 1 instruction each second

1 Kilohertz (KHz) = 1000 clock cycles per second

1 Megahertz (MHz) = 1,000,000 clock cycles per second

1 Gigahertz (GHz) = 1,000,000,000 clock cycles per second

Factors that can affect CPU performance

1 - Clock Speed

- By increasing the clock speed, the processing speed of the computer is also increased.
- The speed of the computer can be changed using the **BIOS**.



Factors that can affect CPU performance

1 - Clock Speed

- By increasing the clock speed, the processing speed of the computer is also increased.
- The speed of the computer can be changed using the **BIOS**.
- Increasing the CPU clock speed is called **over-clocking**.
- A faster CPU requires more power and so, more heat is generated.
- The CPU has a limit to which it can work before data corruption and overheating occurs.

Factors that can affect CPU performance

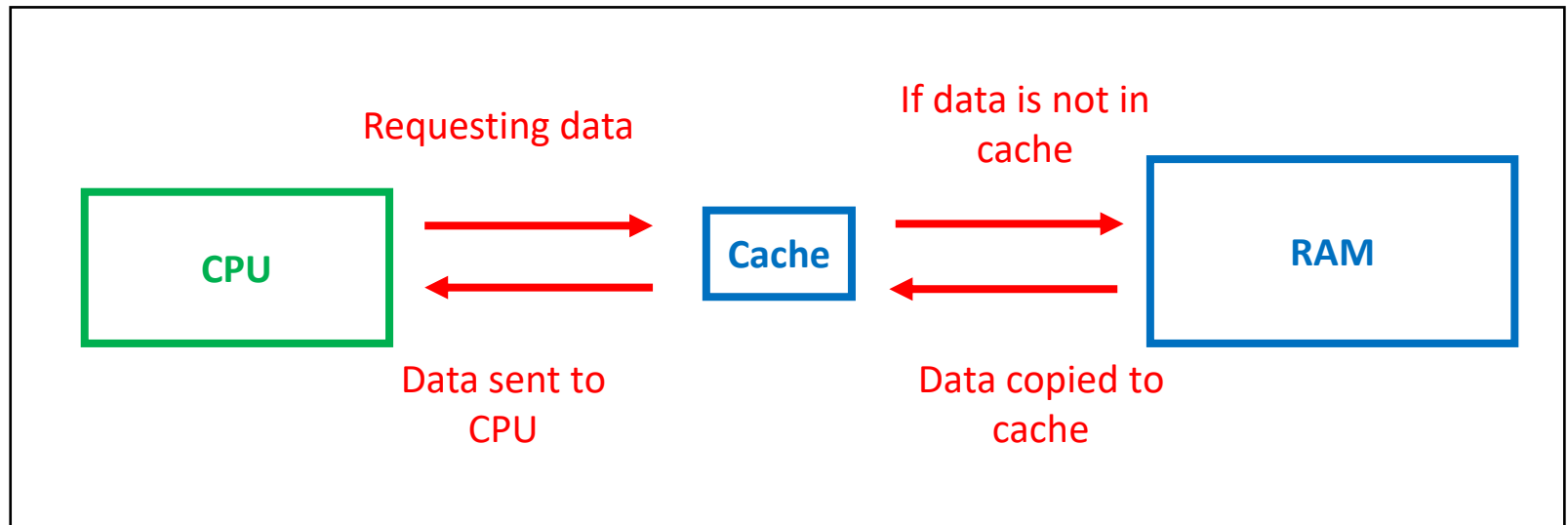
2 - Cache size

- Cache is a small memory part that is located within the CPU itself -> much faster data access times than RAM
- It temporarily holds data and instructions that the CPU is frequently using.
- To reduce data **access time**, the Control Unit checks cache before requesting data / instructions from RAM
- The larger the cache size the better the CPU performance
- Compared to RAM, cache is expensive as storage.

Factors that can affect CPU performance

2 - Cache size

- Cache allows the speed of the CPU to increase, as compared to RAM, it is a **closer location** and allows **faster access times**.



Factors that can affect CPU performance

2 - Cache size

- There are different levels of cache:

Level	Size	Location	Access time	
1	8 KB to 64 KB	Built into CPU chip	Fastest (runs at the speed of CPU)	Smallest cache in the CPU
2	Bigger than L1	Between CPU and RAM. Sometimes built into CPU with L1	Slightly longer than L1	The more memory available with L2 and L3, the faster a computer can run.
3	Bigger than L2	Between CPU and RAM but further away from CPU.	Slightly longer than L2	

Factors that can affect CPU performance

3 - Number of Cores

- A CPU consists of multiple processing units. Each processing unit is known as **core**.
- A core consists of a processor (ALU and CU) and registers.
- Computers may be dual (two), quad (four) or even more cores.
- As the number of cores increases, the computer has more power to execute multiple programs at the same time.

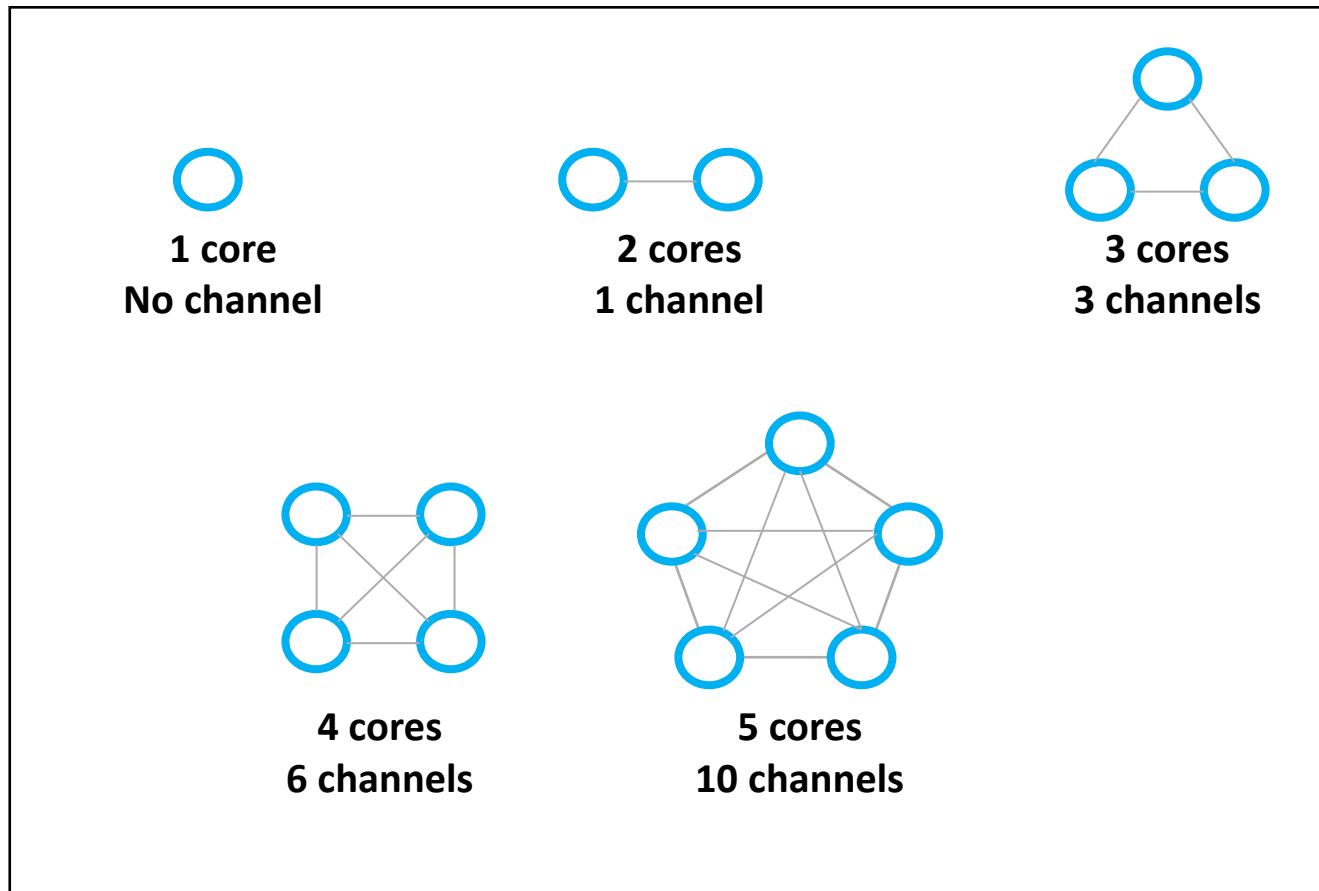
Factors that can affect CPU performance

3 - Number of Cores

- However, increasing the number of cores four times does not increase the speed of the computer four times.
- This is because when the number of cores is increased, the communication channels between the cores also use up some of the speed.
- Hence, increasing the number of cores four times will not increase the speed of the computer four times.

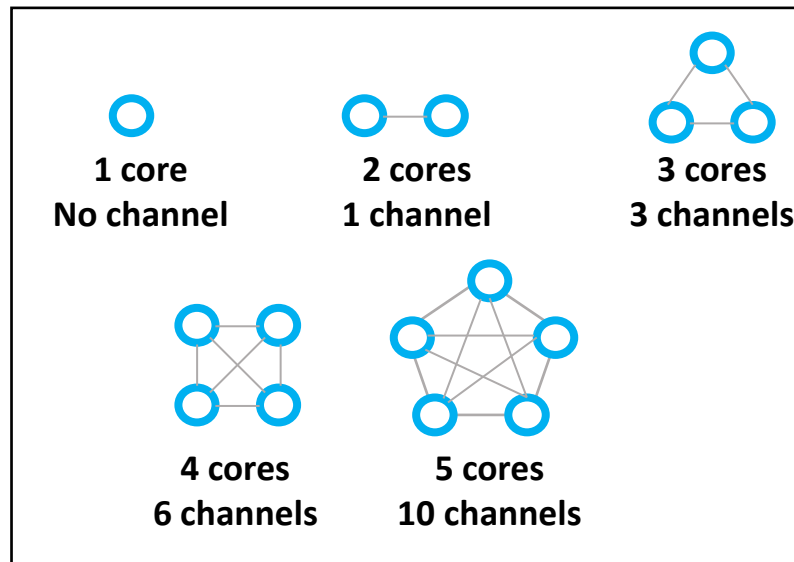
Factors that can affect CPU performance

3 - Number of Cores



Factors that can affect CPU performance

3 - Number of Cores



- The more cores there are, the greater the reduction in potential performance due to the need for the CPU to communicate with each core (more cores -> more channels).

Activity

Go to the [Dell website](#) and compare the [different processor specifications](#) of the computers to find the one that you think would make a good gaming machine.

Explain why it would be a good choice for playing games.




Available Colors:




ALIENWARE AURORA R12 GAMING DESKTOP

★★★★★ 4.3 (1602) [Ask a question](#)


 11th Gen Intel® Core™ i5 11400F (6-Core, 12MB Cache, 2.6Ghz to 4.4GHz)

 Windows 11 Home, English

 NVIDIA® GeForce RTX™ 3060 12GB GDDR6

 8GB DDR4 XMP at 3200MHz; up to 128GB (additional memory sold separately)

 256GB M.2 PCIe NVMe SSD

 Dark Side of the Moon

 [Ports & Slots](#)

\$1,499.99

Instruction set

An **Instruction Set** is a list of all the commands that can be processed by a CPU.

- They are the low-level language instructions that tell the CPU how to carry out an operation / task.

Instruction	Operation
JUMP Γ	GOTO Γ
<i>Jcond</i> Γ	If condition is true then GOTO Γ
CALL Γ	Call subroutine at Γ
<i>Ccond</i> Γ	If condition is true then call subroutine at Γ
RET	Return from subroutine
<i>Rcond</i>	If condition is true then return from subroutine

Instruction set

An **Instruction Set** is a list of all the commands that can be processed by a CPU.

- Each operation will instruct the ALU and CU
- High level program code needs to be converted into the instruction set so that it can be understood by the computer.
- The instruction set is made up of **opcodes**. There are only a limited number of **opcodes** that can be used (e.g. ADD, JMP, LDA etc).

Instruction set

An **Instruction Set** is a list of all the commands that can be processed by a CPU.

- An operation / task is made up of an **opcode** and an **operand**
- The **opcode** tells the CPU what operation needs to be done - the instruction. There are only a limited number of **opcodes** (e.g. ADD, JMP, LDA etc).
- The **operand** is either the **data** that needs processing, or an **address** in the memory

Summary

- CPU performance can be affected by a number of factors:
 - the number of cores
 - size of cache
 - the clock speed
- An instruction set is a list of all the commands in machine code that can be processed by a CPU
- The Fetch-Decode-Execute cycle is the sequence of steps used by the CPU to process each instruction in a program, in sequence

