STUDENT WORKBOOK

1.1.1

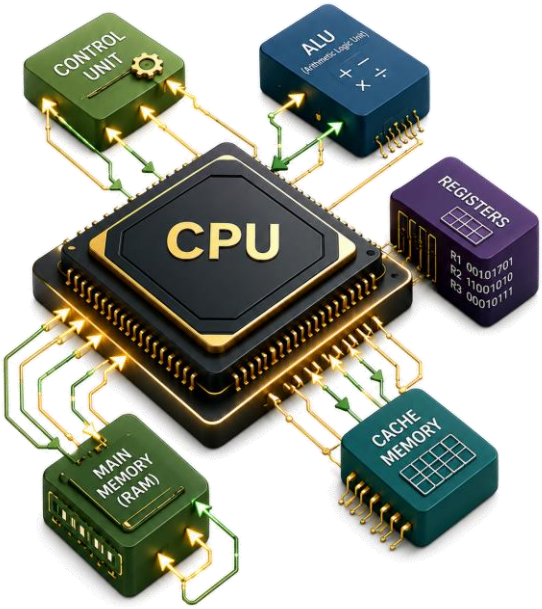
ARCHITECTURE OF THE CPU

OCR GCSE Computer Science (J277)

LEARNING OBJECTIVES

By the end of this lesson, you should be able to:

- Describe the purpose of the CPU and explain its role in running programs.
- Explain the stages of the fetch-decode-execute cycle and how instructions are processed.
- Identify the ALU, Control Unit, Cache and Registers and describe each function.
- Explain the principles of the Von Neumann architecture.
- Describe the purpose of the MAR, MDR, Program Counter and Accumulator.
- Apply your knowledge to explain how data and instructions move through the CPU.



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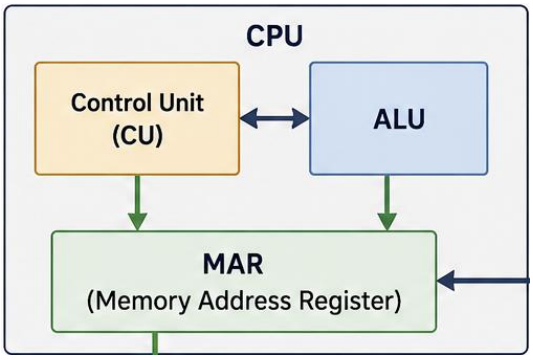


WHAT IS THE CPU? & VON NEUMANN ARCHITECTURE

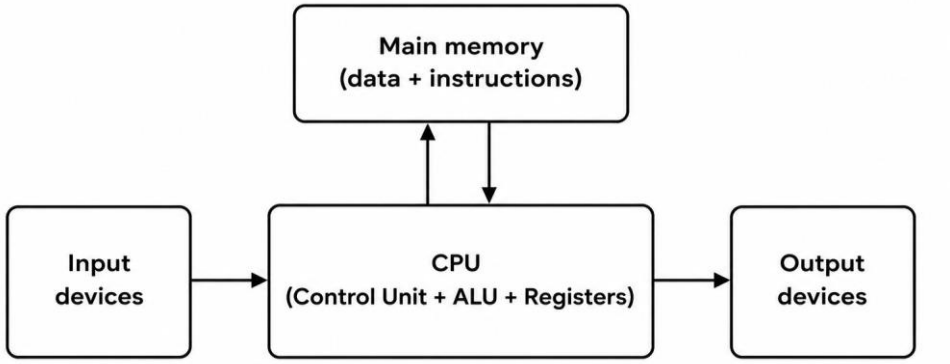
KEY IDEA

The CPU (Central Processing Unit) is the part of a computer that processes instructions. It controls the operation of the computer and carries out the instructions that make programs run.

A. Complete the guided notes

- The CPU is often described as the _____ of the computer.
- It repeatedly fetches, _____ and executes instructions.
- Programs are made up of a sequence of _____.
- The CPU communicates with memory and input/output devices using _____.
- Processed results may be stored in registers, memory or sent to an _____ device.

B. Study the simplified Von Neumann architecture



- One shared memory stores both program instructions and data.
- Buses carry addresses, data and control signals between components.

VOCABULARY

- Instruction: a command for the CPU.
- Data: values being processed.
- Bus: a set of connections used to carry data, addresses or control signals.

1. What is stored together in main memory in the Von Neumann architecture? [2]

_____

_____

2. Why is this architecture useful for a general-purpose computer? [2]

_____

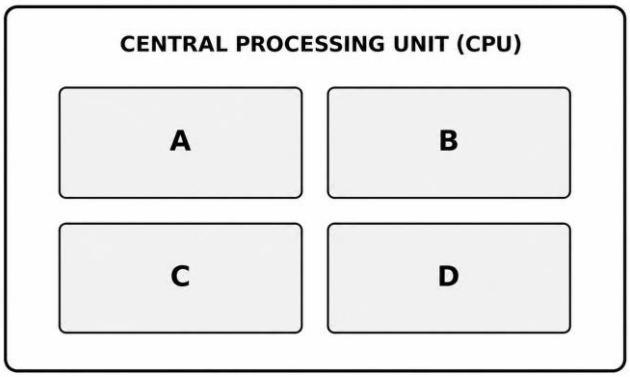
_____

GCSE EXAM TIP

The Von Neumann architecture is the most common design used in modern computers. Remember: data and instructions memory.

MAIN COMPONENTS OF THE CPU

Use the four terms to label boxes A–D: ALU, Control Unit, Cache, Registers.



Use: ALU • Control Unit • Cache • Registers

Complete the table in your own words.

Component	What does it do?	Example of its role
ALU		
Control Unit		
Cache		
Registers		

Which component performs arithmetic calculations and logical comparisons? [1]

_____

Explain one reason why cache can improve CPU performance. [2]

_____

_____

Why does the CPU need registers as well as main memory? [2]

_____

_____

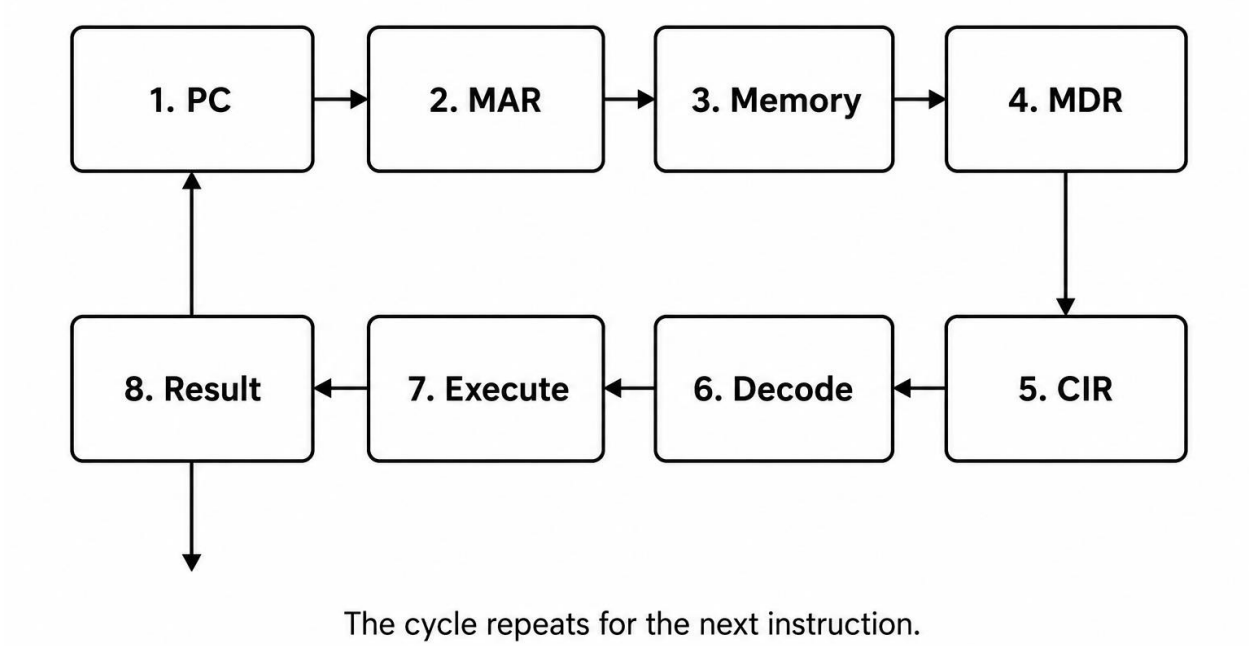
_____

CHALLENGE

If the CPU could only access data from main memory, how would this affect performance?

THE FETCH-DECODE-EXECUTE CYCLE

The CPU repeats this cycle while a program is running. Annotate the diagram with a short description of what happens at each numbered stage.



SEQUENCE CHALLENGE

Put these in the correct order:

- ○ The address in the Program Counter is copied to the MAR.
- ○ The instruction at that address is copied from memory to the MDR.
- ○ The instruction is copied to the Current Instruction Register (CIR).
- ○ The Program Counter is increased so it points to the next instruction.
- ○ The Control Unit decodes the instruction.
- ○ The instruction is executed by the appropriate CPU component.

GCSE EXAM TIP

Learn the order of the cycle. In exams you may be asked to state, explain or order the stages correctly.

Explain why the Program Counter must be updated during the cycle. [2]

_____

_____

_____

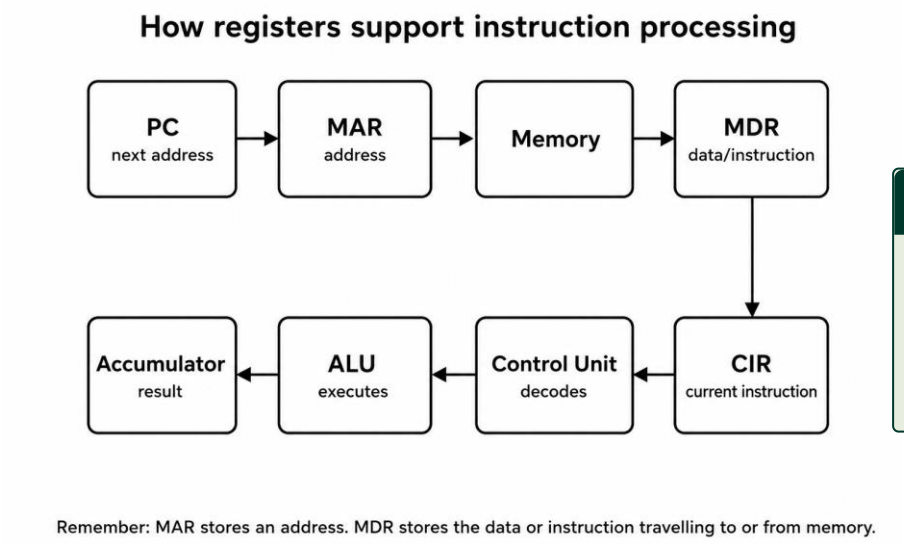
What is the difference between decoding and executing an instruction? [2]

_____

_____

KEY CPU REGISTERS

Registers are very small, very fast storage locations inside the CPU. Study the flow, then complete the table.



REMEMBER

- MAR stores an address.
- MDR stores the data or instruction travelling to or from memory.

Register	Full name	Purpose
MAR	Memory Address Register	
MDR	Memory Data Register	
PC	Program Counter	
ACC	Accumulator	

Register check (Circle correct answer)

1. **Stores an address that will be sent to memory:** MAR / MDR / PC / ACC
2. **Stores the next instruction address:** MAR / MDR / PC / ACC
3. **Stores data travelling from memory:** MAR / MDR / PC / ACC
4. **Stores a calculation result:** MAR / MDR / PC / ACC

A student says, "The MAR and MDR do the same job." Explain why this is incorrect. [2]

_____

_____

CHALLENGE

If the MDR failed, what stage of the fetch cycle would be affected and why?

APPLY YOUR KNOWLEDGE & EXAM PRACTICE

A program is running. The next instruction is stored at memory address 204. The instruction tells the CPU to add two values and store the result.

Explain the journey of the instruction

Describe how the instruction at address 204 is fetched, decoded and executed. Include the PC, MAR, MDR, CIR, Control Unit, ALU and Accumulator in your answer. [6]

_____

_____

_____

_____

_____

Exam-style questions

1. **State the purpose of the CPU. [1]**

   _____

   _____

2. **Explain the role of the Control Unit. [2]**

   _____

   _____

3. **Describe one principle of the Von Neumann architecture. [2]**

   _____

   _____

4. **Explain how cache helps the CPU run programs efficiently. [2]**

STUDENT CHECK

How confident are you with today's lesson?

- Very confident
- Confident
- Unsure
- Need more practice
- Not confident yet

NEXT STEPS

Write one thing you will revise before the next lesson.

_____

_____