CAMBRIDGE IGCSE (0478)

Module A: Systems architecture

Workbooklet · 7 parts · 140 marks

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	Total	**140**

MODULE A SYSTEMS ARCHITECTURE · A1

What a computer system is and what the CPU does

Original practice questions · ~25 minutes · 20 marks · Cambridge 0478 syllabus 3.1.1(a)

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 7 marks

A museum has a self-service information kiosk. A visitor scans a code on their entry ticket with a barcode scanner. The kiosk shows a map on a screen, plays a description through a speaker and loads the map images from a hard disk drive.

(a) State what is meant by the abbreviation CPU. **[1]**

(b) Describe the role of the CPU in the kiosk. **[2]**

(c) Tick (✓) **one** box in each row to show whether each device is an input device, an output device or a storage device. **[4]**

Device	Input	Output	Storage
Barcode scanner			
Screen			
Speaker			
Hard disk drive			

2 **Total: 5 marks**

The CPU in the kiosk runs a program by repeating a cycle.

(a) Tick (✓) **one** box to show the name of this cycle. **[1]**

Name	Tick (✓)
Input-store-output cycle	
Fetch-decode-execute cycle	
Load-save-print cycle	

(b) Complete the sentences about how the CPU runs a program. **[4]**

While the program is running, its instructions and data are held in main memory, called ..... .

The CPU ..... an instruction from main memory.

The CPU then ..... the instruction to work out what it means.

Finally the CPU ..... the instruction, which means it carries it out.

3 **Total: 3 marks**

Describe the fetch-decode-execute (FDE) cycle. **[3]**

4 **Total: 3 marks**

An office worker scans a paper invoice. A few seconds later, a copy of the invoice appears on the monitor.

Explain why the CPU is needed for the scanned invoice to appear on the monitor. **[3]**

5 **Total: 2 marks**

Tick (✓) **two** boxes to show the statements about the CPU that are true. **[2]**

Statement	Tick (✓)
The CPU stores programs permanently when the computer is switched off.	
The CPU processes instructions and data.	
A hard disk drive is part of the CPU.	
The CPU repeats the FDE cycle for each instruction in a program.	

Total for this worksheet: 20 marks

MODULE A SYSTEMS ARCHITECTURE · A2

Inside the CPU: ALU, CU, cache and registers

Original practice questions · ~25 minutes · 20 marks · Cambridge syllabus 3.1.2(a), 3.1.3

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 3 marks

A car park barrier has a computer with a Von Neumann architecture. It works out how long each car has stayed.

(a) State the name of the unit in the CPU that carries out calculations. **[1]**

(b) Give **two** types of operation this unit carries out for the car park barrier. **[2]**

2

Total: 5 marks

Tick (✓) **one** box in each row to show whether each register stores an address or stores data (including instructions).

(a) Complete the table. **[5]**

Register	Address	Data
Program counter (PC)		
Memory address register (MAR)		
Memory data register (MDR)		
Current instruction register (CIR)		
Accumulator (ACC)		

3 **Total: 4 marks**

Complete the statements by writing the name of the correct register.

(a) Complete the statements. **[4]**

Statement	Register
It holds the address of the next instruction to be fetched.	
It holds the instruction that is currently being decoded and executed.	
It stores the result of a calculation carried out by the ALU.	
It holds the address of the memory location that is about to be read from or written to.	

4 **Total: 3 marks**

(a) Describe the purpose of the control unit (CU) in a CPU. **[3]**

5 **Total: 2 marks**

While the barrier's computer runs a program, the MAR holds the value 40. Later, the MDR also holds the value 40.

(a) Explain why the value 40 has a different meaning in each register. **[2]**

6 **Total: 3 marks**

The barrier's CPU has cache.

(a) Explain how cache can improve the performance of the CPU. **[3]**

Total for this worksheet: 20 marks

MODULE A SYSTEMS ARCHITECTURE · A3

Von Neumann architecture and the buses

Original practice questions · ~25 minutes · 20 marks · 0478 syllabus 3.1.2(a)

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 3 marks

A ticket machine at a railway station has a CPU with Von Neumann architecture. The CPU fetches instructions and data from random access memory (RAM).

(a) State **one** feature of Von Neumann architecture about where instructions and data are stored. **[1]**

(b) Identify **two** registers in the CPU that store an address. **[2]**

2

Total: 4 marks

(a) Complete the table by writing the name of the register that matches each description. **[4]**

Description	Register
Stores the data or instruction that has just been fetched from RAM	
Stores the instruction that is currently being decoded and executed	
Stores the address of the next instruction to be fetched	
Stores the result of a calculation carried out by the ALU	

3 **Total: 5 marks**

The CPU is connected to RAM by three buses: the address bus, the data bus and the control bus.

(a) Tick (✓) **one** box in each row to show which bus each statement describes. **[5]**

Statement	Address bus	Data bus	Control bus
Carries a read or write signal from the control unit			
Carries the location in RAM that the MAR is pointing to			
Carries an instruction from RAM to the MDR			
Only carries signals in one direction, from the CPU to RAM			
Carries a value from the MDR to be stored in RAM			

4 **Total: 5 marks**

The ticket machine needs to read the price of a ticket. The price is stored in RAM at address 0110 1100.

(a) State the name of the register that sends the address 0110 1100 onto the address bus. **[1]**

(b) Describe how the buses are used to read the price from RAM into the CPU. **[4]**

5 **Total: 3 marks**

(a) Explain why the data bus needs to carry data in both directions but the address bus only carries addresses in one direction. **[3]**

Total for this worksheet: 20 marks

MODULE A SYSTEMS ARCHITECTURE · A4

The fetch-decode-execute (FDE) cycle

Original practice questions · ~25 minutes · 20 marks · Cambridge 0478 syllabus 3.1.2(b)

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 2 marks

(a) State the name of the register that holds the instruction that is currently being decoded and executed. **[1]**

(b) Tick (✓) **one** box to show which bus carries an address from the CPU to memory. **[1]**

Bus	Tick (✓)
Address bus	
Control bus	
Data bus	

2

Total: 6 marks

The paragraph describes the fetch stage of the FDE cycle.

(a) Complete the paragraph using terms from the list. Not all terms are used. **[6]**

accumulator · address bus · ALU · CIR · control bus · data bus · MAR · MDR · program counter (PC) · secondary storage

The address of the next instruction is held in the _____. This address is copied into the _____. The address is sent to RAM along the _____. The instruction stored at that address is sent back to the CPU along the _____ and is stored in the _____. The instruction is then copied into the _____, and the PC is incremented.

3 Total: 4 marks

(a) Tick (✓) **one** box in each row to show whether the register stores an **address** or **data / an instruction**. **[4]**

Register	Address	Data / instruction
Program counter (PC)		
Memory address register (MAR)		
Current instruction register (CIR)		
Accumulator (ACC)		

4 Total: 5 marks

A ticket barrier at a train station has a CPU that runs a program to check tickets. At the start of a cycle, the program counter (PC) holds 150.

(a) State the value held in the PC after the instruction at address 150 has been fetched. **[1]**

(b) The instruction at address 150 is: *load the value stored at address 300 into the accumulator*. Describe how this instruction is executed. Include the registers and buses that are used. **[4]**

5 **Total: 3 marks**

(a) Explain the role of the control unit (CU) in the FDE cycle. **[3]**

Total for this worksheet: 20 marks

MODULE A SYSTEMS ARCHITECTURE · A5

CPU performance

Original practice questions · ~25 minutes · 20 marks · 0478 syllabus 3.1.3

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 4 marks

A weather service uses a computer to process readings from its weather stations. The computer's CPU has a clock speed of 2.5 GHz.

(a) Tick (✓) one box to show what the clock speed of a CPU measures. **[1]**

Description	Tick (✓)
The number of instructions stored in cache	
The number of fetch-decode-execute cycles carried out per second	
The number of cores that can work at the same time	
The amount of data that can be stored in RAM	

(b) State how many fetch-decode-execute cycles per second a clock speed of 2.5 GHz represents. **[1]**

(c) Explain how increasing the clock speed could improve the performance of the CPU. **[2]**

2 **Total: 5 marks**

The CPU has 4 MiB of cache. The weather service is thinking about a CPU with 8 MiB of cache instead.

(a) Describe what is meant by cache. **[2]**

(b) Explain why increasing the size of the cache from 4 MiB to 8 MiB could improve the performance of the CPU. **[3]**

3 **Total: 4 marks**

The weather service replaces its dual-core CPU with a quad-core CPU. The clock speed and cache size stay the same.

(a) Explain how having more cores could improve the performance of the CPU. **[2]**

(b) One program the weather service uses is no faster on the quad-core CPU. Explain why. **[2]**

4 **Total: 4 marks**

(a) Tick (✓) one box in each row to show whether each statement is true or false. **[4]**

Statement	True (✓)	False (✓)
Each core in a CPU can fetch, decode and execute its own instructions.		
Cache is slower to access than RAM.		
A clock speed of 3 GHz means 3 million cycles per second.		
A larger cache means the CPU needs to fetch from RAM less often.		

5 **Total: 3 marks**

A video editing company finds that its computer's CPU often has to wait for data and instructions to arrive from RAM.

(a) Identify the CPU characteristic the company should change to reduce this waiting. Explain how the change would help. **[3]**

Total for this worksheet: 20 marks

MODULE A SYSTEMS ARCHITECTURE · A6

Embedded systems

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 3.1.5

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 2 marks

(a) Describe the purpose of an embedded system. **[2]**

2

Total: 3 marks

(a) Circle **three** devices that are most likely to contain an embedded system. **[3]**

electric oven	desktop computer	street-lighting controller
laptop	train-ticket machine	paper notebook

3 **Total: 5 marks**

A plant nursery has a greenhouse with automatic roof vents. A control unit inside the vent motor reads a temperature sensor. When the air is too warm, it opens the vents. When the air has cooled, it closes them.

(a) State the dedicated function of the control unit. **[1]**

(b) Explain why the control unit is an embedded system. **[2]**

(c) Give **two** characteristics of an embedded system. **[2]**

1

2

4 **Total: 4 marks**

(a) Tick (✓) **one** box in each row to show whether each statement is true for an embedded system, a general purpose computer, or both. **[4]**

Statement	Embedded system	General purpose computer	Both
It performs one dedicated function			
The user can install many different applications on it			
It contains a processor that runs instructions			
It is built into a larger device, such as a car			

5 **Total: 4 marks**

An architect uses a personal computer (PC) at work. Her home has a security system with a keypad, door sensors and an alarm.

(a) Explain the difference between the security system's control unit and the architect's PC. Refer to both in your answer. **[4]**

6 **Total: 2 marks**

(a) Give **two** examples of embedded systems that can be found in a car. **[2]**

1

2

Total for this worksheet: 20 marks

MODULE A SYSTEMS ARCHITECTURE · A7 (IGCSE ONLY)

Instruction sets and microprocessors

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 3.1.1(b), 3.1.4

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 3 marks

A smart thermostat contains a CPU. The CPU is a microprocessor.

(a) State what is meant by a **microprocessor**. **[1]**

(b) State what is meant by an **instruction set**. **[2]**

2

Total: 3 marks

(a) Tick (✓) **one** box in each row to show whether each statement is true or false. **[3]**

Statement	True	False
A microprocessor is a type of integrated circuit on a single chip		
A CPU can execute a command that is not in its instruction set		
Every type of CPU has exactly the same instruction set		

3 **Total: 6 marks**

A training kit has a simple, made-up CPU. The table shows its **whole** instruction set.

Code	Meaning
00	LOAD a number into the accumulator
01	ADD a number to the accumulator
10	STORE the accumulator in memory
11	OUTPUT the accumulator

(a) The codes in the table are in binary. State the name given to the binary commands in an instruction set. **[1]**

(b) An engineer writes a program that needs a SUBTRACT command. Explain why this CPU cannot run the program. **[2]**

(c) The engineer needs the CPU to output the result of 5 × 3. There is no multiply command. Describe how this can be done using **only** the commands in the table. **[3]**

4 **Total: 4 marks**

(a) Complete the sentences about how a CPU uses its instruction set. Use words from the list. **[4]**

ALU	control unit	decoded	executed	RAM	ROM	secondary storage

During the fetch stage, an instruction is copied from ..... into the CPU.

The instruction is then ..... by the ....., which works out which command from the instruction set it is.

Finally, the instruction is ..... .

5 **Total: 2 marks**

(a) Give **two** examples of commands that could be in a CPU's instruction set. **[2]**

1

2

6 **Total: 2 marks**

A software company makes a program in machine code for the CPU in a desktop computer. A mobile phone has a different type of CPU.

(a) Explain why the program might not run on the mobile phone's CPU. **[2]**

Total for this worksheet: 20 marks