OCR GCSE (J277)

Module A: Systems architecture

Workbooklet mark scheme · 6 parts · 120 marks

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	Total	**120**

MODULE A SYSTEMS ARCHITECTURE · A1

What a computer system is and what the CPU does: mark scheme

~25 minutes · 20 marks · OCR J277 spec 1.1.1

How to use. 1 mark per bullet up to the maximum shown. **/** separates alternative words; **//** separates alternative statements for the same mark. Words in (brackets) are not needed for the mark. Credit any other valid answer that shows the same understanding.

QUESTION	ANSWER	MARKS	GUIDANCE
1(a) J277 1.1.1	Central Processing Unit	**1**	All three words needed. Do not accept "Central Processor Unit" / "Computer Processing Unit".
1(b) J277 1.1.1	To process data and instructions // to run programs // to fetch and execute instructions // to work out the charge from the data entered	**1**	Max 1. Do not accept "to process information" alone (NE). Do not accept "to store data / programs".
1(c) J277 1.1.1	Keypad: Input CPU: Processing Ticket printer: Output Solid state drive: Storage	**4**	1 mark per correct row. 2+ ticks in a row = 0 for that row.
2(a) J277 1.1.1	Main memory (RAM)	**1**	2+ ticks = 0 marks.
2(b) J277 1.1.1	instruction memory carried out repeats	**4**	1 mark per correct word, in order. Correct answer only.
3 J277 1.1.1	An instruction / data is fetched from (main) memory / RAM The instruction is decoded // the CPU works out what the instruction means The instruction is executed / carried out The cycle repeats (for the next instruction) // continues until the program ends	**3**	1 mark per bullet, max 3. Do not accept "programs are fetched" or "information is processed" (NE). Register-level detail is not needed (covered in A4), but credit correct detail, e.g. address of the next instruction held in the PC.
4 J277 1.1.1	A hard disk drive is part of the CPU: False Fetch-execute cycle repeated continuously: True CPU processes data and instructions to run programs: True	**3**	1 mark per correct row. 2 ticks in a row = 0 for that row.

QUESTION	ANSWER	MARKS	GUIDANCE
5 J277 1.1.1	The app / its instructions (and data) are copied / loaded from secondary storage into RAM (While it runs) the app's instructions / data are held in RAM The CPU fetches the instructions (and data) from RAM The CPU decodes and executes the instructions ... one after another / repeatedly (in the fetch-execute cycle)	**3**	1 mark per bullet, max 3. Do not accept "the CPU stores the app" or that the CPU runs the app directly from secondary storage. Do not credit mention of buses (not required for J277).

Total: 20 marks

MODULE A SYSTEMS ARCHITECTURE · A2

Inside the CPU: mark scheme

~25 minutes · 20 marks · OCR spec 1.1.1

How to use. 1 mark per bullet up to the maximum shown. **/** separates alternative words; **//** separates alternative answers for the same mark. Words in (brackets) are not needed for the mark.

QUESTION	ANSWER	MARKS	GUIDANCE
1(a) J277 1.1.1	Arithmetic Logic Unit	**1**	Accept Arithmetic and Logic Unit. Correct answer only.
1(b) J277 1.1.1	Arithmetic / calculations, e.g. adding up the price of two tickets // subtracting a discount Logic / comparisons, e.g. checking whether the money paid is greater than / equal to the price	**2**	1 mark per type with a suitable example. Mark first two answers. Do not accept "calculations" for both. Do not accept "processing" (NE). Also accept a Boolean logic operation (AND / OR / NOT) for the logic mark.
2(a) J277 1.1.1	Decodes an instruction: Control unit Greater than check: ALU Frequently used instructions and data: Cache Small fast locations: Registers	**4**	1 mark per row. 2+ ticks in a row = 0 marks for that row.
3(a) J277 1.1.1	PC: holds the address of the next instruction (to be fetched) MAR: holds the address of the memory location that is to be read from / written to // the address of the data/instruction to be fetched MDR: holds the data/instruction fetched from memory // the data to be written to memory Accumulator: holds the result of calculations (done by the ALU)	**4**	1 mark per row. Do not accept PC "counts the number of programs" / "counts instructions". MAR and PC must refer to an address. Do not accept MDR "holds an address".
3(b) J277 1.1.1	Program counter / PC Memory address register / MAR	**2**	Either order. If more than two given, mark the first two.
4(a) J277 1.1.1	In the MAR, 12 is an address // the location in memory to be read from / written to In the MDR, 12 is data // a value that came from / is going to memory	**2**	Accept MDR value described as an instruction (an instruction is held as data). Do not accept "12 is the same in both".

QUESTION	ANSWER	MARKS	GUIDANCE
5(a) J277 1.1.1	Decodes instructions // works out what an instruction means Sends (control) signals to coordinate / control the other components / the flow of data Controls the fetch-execute cycle	**2**	Max 2. Do not accept "does the calculations" (that is the ALU). "Controls the computer" alone is NE.
6(a) J277 1.1.1	Cache is (small, very fast) memory inside / close to the CPU It stores frequently used instructions / data // the instructions run on every scan Cache is faster to access than RAM // the CPU does not have to fetch them from (slower) RAM each time So less time is spent waiting for instructions / data // instructions are fetched more quickly	**3**	Max 3. "Faster" must be compared with RAM / main memory. Do not accept cache as secondary storage. Do not accept "stores the whole program permanently".

Total: 20 marks

MODULE A SYSTEMS ARCHITECTURE · A3

Von Neumann architecture: mark scheme

~25 minutes · 20 marks · J277 spec 1.1.1

How to use. 1 mark per bullet up to the maximum shown. **/** separates alternative words; **//** separates alternative statements for the same mark. Words in (brackets) are not needed for the mark. NE = not enough. Credit any other valid answer that shows the same understanding.

QUESTION	ANSWER	MARKS	GUIDANCE
1(a) J277 1.1.1	(In the same) main memory / RAM / memory	**1**	Do not accept: secondary storage, hard drive, ROM, cache, registers.
1(b) J277 1.1.1	The program / instructions are stored in (main) memory (with the data) Instructions are fetched (from memory) and executed by the CPU ... one at a time / in turn / in sequence	**2**	Max 2. Third point depends on the second. "Programs are processed" is NE.
2(a) J277 1.1.1	Row 1: Program counter / PC MAR: holds the address (of the memory location) that is to be read from / written to // holds the address of the data or instruction being fetched MDR: holds the data / instruction that has been fetched from memory // holds data to be written to memory Row 4: Accumulator / ACC	**4**	1 mark per row. MAR: must say address. MDR: must say data or instruction (not "address"). "Holds memory" is NE.
3(a) J277 1.1.1	Program counter / PC MAR / memory address register	**2**	Mark the first two answers only. MDR or accumulator scores 0 for that answer.
4(a) J277 1.1.1	46	**1**	Correct answer only.
4(b)(i) J277 1.1.1	41	**1**	Correct answer only.
4(b)(ii) J277 1.1.1	ADD 46 // the instruction (stored) at address 41	**1**	Do not accept 46 alone or 150.
4(c) J277 1.1.1	An address identifies a (unique) location in memory // says where something is stored Data is the value / contents stored at that location Example from the table, e.g. address 45 holds the data 250	**2**	Max 2. The example can earn a mark on its own if it clearly separates the address from the contents.

QUESTION	ANSWER	MARKS	GUIDANCE
5(a) J277 1.1.1	Row 1: False ... the program counter holds the address of the next instruction (to be fetched) Row 2: True Row 3: False ... the MAR holds the address // the MDR holds the data / instruction (being transferred to or from memory)	**3**	1 mark per row. False rows need a correct rewrite for the mark. Two ticks in a row = 0 for that row.
6(a) J277 1.1.1	The new program is (loaded and) stored in (main) memory Instructions and data are stored in the same memory // instructions are just stored values like data ... so changing the program only changes what is in memory, not the hardware The CPU fetches and executes the (new) instructions from memory ... the PC is set to the address of the first instruction of the new program	**3**	Max 3. Must be applied to the pay machine / its program for full marks; generic answers max 2.

Total: 20 marks

MODULE A SYSTEMS ARCHITECTURE · A4

The fetch-execute cycle: mark scheme

20 marks · OCR J277 spec 1.1.1

How to use. 1 mark per bullet up to the maximum shown. **/** separates alternative answers. Words in (brackets) are not needed for the mark. Credit any other valid answer that shows the same understanding. Register-to-register transfers are not required by J277 (1.1.1 "Not required"), but credit them when they are correct.

QUESTION	ANSWER	MARKS	GUIDANCE
1(a) J277 1.1.1	To fetch and execute instructions / to run (the instructions of) programs / to process data and instructions	**1**	Allow "carries out the fetch-execute cycle". Do not accept "the brain of the computer" or "does calculations" on its own (NE).
1(b) J277 1.1.1	(Main) memory / RAM	**1**	Allow cache. Do not accept hard disk / secondary storage / ROM on its own.
2(a) J277 1.1.1	Brought from memory into the CPU: Fetch ALU adds two numbers: Execute PC incremented: Fetch Result stored in accumulator: Execute PC used to find the next address: Fetch	**5**	1 mark per correct row. 2 ticks in a row = 0 for that row.
3(a) J277 1.1.1	PC: Address MAR: Address MDR: Data Accumulator: Data	**4**	1 mark per correct row. 2 ticks in a row = 0 for that row.
4(a) J277 1.1.1	41	**1**	Correct answer only.
4(b) J277 1.1.1	Control unit / CU	**1**	Do not accept ALU / "the CPU" (NE).
4(c) J277 1.1.1	The value (stored) at address 90 is fetched / read from memory (into the CPU) (Address 90 goes into the MAR and) the value is held in the MDR The CU sends signals to the ALU / the ALU carries out the addition The ALU adds the value to the value in the accumulator The result is stored in the accumulator	**3**	1 mark per bullet, Max 3. Do not accept "the accumulator stores the calculation" for the last bullet: it stores the result. Do not award points about fetching the instruction at address 40.

QUESTION	ANSWER	MARKS	GUIDANCE
5(a) J277 1.1.1	The PC holds the address of the next instruction (to be fetched) The instruction is fetched from (main) memory / RAM (at that address) The PC is incremented / increased by 1 (to point to the next instruction) The (fetched) instruction is held in the MDR The control unit decodes the instruction / works out what it means The instruction is executed / carried out (e.g. the ALU does a calculation / data is loaded or stored) The result (of a calculation) is stored in the accumulator The cycle repeats (continuously) for the next instruction	**4**	1 mark per bullet, Max 4. Points can be in any order. Allow the PC to be incremented either before or after the instruction arrives. "Fetch, decode, execute" listed with no description = 0. Do not accept "the CPU fetches it from the hard disk".

Total: 20 marks

MODULE A SYSTEMS ARCHITECTURE · A5

CPU performance: mark scheme

~25 minutes · 20 marks · J277 spec 1.1.2

How to use. 1 mark per bullet up to the maximum shown. **/** separates alternative words; **//** separates alternative statements for the same mark. Words in (brackets) are not needed for the mark. Credit any other valid answer that shows the same understanding.

QUESTION	ANSWER	MARKS	GUIDANCE
1(a) J277 1.1.2	Row 1: clock speed Row 2: number of cores Row 3: cache size	**3**	1 mark per row. 2+ ticks in a row = 0 for that row.
1(b) J277 1.1.2	3.2 billion / 3 200 000 000 / 3200 million (cycles per second)	**1**	Correct answer only. Accept 3.2×10^9.
1(c) J277 1.1.2	More (fetch-execute) cycles (carried out) per second… …so more instructions are processed/executed per second // so programs run faster / performance improves	**2**	Max 2. Do not accept "the computer is faster" alone (NE). Do not accept "more cycles at the same time" (that describes cores).
1(d) J277 1.1.2	2 500 000 000 // 2.5 billion // 2500 million	**1**	Accept 2.5×10^9. Do not accept 2.5 million or 2 500 000 (wrong prefix).
2(a) J277 1.1.2	Frequently used data / instructions	**1**	Accept "data and instructions that are likely to be needed again". Do not accept "programs" or "files" (NE).
2(b) J277 1.1.2	More (frequently used) data/instructions can be stored in cache… …so fewer (slower) fetches from RAM / main memory are needed // cache is faster to access than RAM so the CPU spends less time waiting (for data/instructions)	**2**	Max 2. "Bigger cache = faster" alone is NE.
3(a) J277 1.1.2	CPU Q (CPU Q) has a higher clock speed / 3.5 GHz compared with 2.0 GHz… …so it carries out more cycles / processes more instructions per second (on the one core used) The program uses only one core, so CPU P's extra cores would not be used / give no benefit Cache size is the same (6 MB) so does not affect the choice	**3**	1 mark for CPU Q, then max 2 for justification. CPU P chosen = 0 for the whole part. Justification must be in context.

QUESTION	ANSWER	MARKS	GUIDANCE
3(b) J277 1.1.2	CPU P has more cores / 4 cores compared with 2 Each core can process (its own) instructions at the same time / simultaneously The program can split its tasks across all 4 cores So more instructions are processed in total (per second) even though each core is slower // 4 × 2.0 GHz gives more total cycles per second than 2 × 3.5 GHz	**3**	Max 3. Combination answers credited (J277 1.1.2 "in combination"). Do not accept "4 cores is four times faster". Accept 8 billion vs 7 billion cycles per second in total.
4(a) J277 1.1.2	Row 1: False Row 2: True Row 3: True Row 4: False	**4**	1 mark per row. 2 ticks in a row = 0 for that row.

Total: 20 marks

MODULE A SYSTEMS ARCHITECTURE · A6

Embedded systems: mark scheme

20 marks · OCR J277 spec 1.1.3

How to use. 1 mark per bullet up to the maximum shown. **/** separates alternative answers. Words in (brackets) are not needed for the mark. Credit any other valid answer that shows the same understanding.

QUESTION	ANSWER	MARKS	GUIDANCE
1(a) J277 1.1.3	A computer system (built) inside a larger device / system ... with a dedicated function / that performs one specific task	**1**	Both ideas needed for the mark. Accept "single purpose" for dedicated function. Do not accept "a small computer" alone.
2(a) J277 1.1.3	Thermostat: embedded Laptop: not embedded Lift controller: embedded Desktop PC: not embedded	**4**	1 mark per correct row. A row with both boxes ticked scores 0.
3(a) J277 1.1.3	To water the plants / to switch the pump on and off depending on how dry the soil is / to keep the soil moist	**1**	Must be in context. Do not accept "to control the greenhouse" alone (too vague).
3(b) J277 1.1.3	It is a computer system / has a processor / runs a program ... ... that is built into a larger device / is part of the pump / watering system It has (only) one dedicated function / only waters the plants It cannot be used for other tasks / the user cannot install other programs on it Its program is fixed / stored in ROM / firmware / hard to change	**3**	1 mark per bullet, max 3. Answers that are generic and not linked to the controller: max 2.

QUESTION	ANSWER	MARKS	GUIDANCE
3(c) J277 1.1.3	Dedicated function (1) ... it only switches the pump on and off to water the plants (1) Part of a larger device (1) ... it is built into the pump (1) Small / compact (1) ... fits on a circuit board inside the pump (1) Low power (1) ... can run all the time / for long periods without using much electricity (1) Low cost (1) ... cheap enough to fit in every pump / many greenhouses (1) Simple / limited user interface (1) ... it only has a power light / no screen (1) Program stored in ROM / firmware / not changed by user (1) ... staff cannot reprogram the controller / it always runs the watering program (1) Reliable / responds in real time (1) ... must switch the pump off when soil is wet, or plants are overwatered / it runs without being looked after (1)	**4**	Two characteristics x 2 marks: 1 for the characteristic, 1 for the link to the controller. The link mark requires the matching characteristic. Do not award the same characteristic twice. Dedicated function credited here even if given in (b).
4(a) J277 1.1.3	(Electronic key-card) door lock Air-conditioning unit Coffee machine	**3**	1 mark each. Do not accept wardrobe, guidebook or laptop. If more than three items are listed, mark the first three.
4(b) J277 1.1.3	It is a general-purpose computer / performs many different functions e.g. the guest can use it for email, games, browsing, documents The user can install / run (any) new software / apps It is not part of a larger device / it is a standalone device	**2**	1 mark per bullet, max 2. Do not accept "it is too big" / "it is too expensive" alone.
5(a) J277 1.1.3	Engine management / engine control system Anti-lock braking (ABS) Satnav / GPS tracking unit Airbag control system Climate control / air conditioning Central locking / alarm / immobiliser Parking sensors / reversing camera system Entertainment / radio system / dashboard display	**2**	1 mark each, max 2. Accept any other valid control system in a vehicle. Do not accept a driver's phone or laptop. Do not accept "the van" / "the engine" alone.

Total: 20 marks