



Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		<p>1 mark each</p> <ul style="list-style-type: none"> • Data/instructions are fetched from memory/RAM/primary storage • Data/instructions are stored using the registers / correct example of a register storing address/data • Data/instructions are decoded / Data/instructions are split into opcode and operand • Data/instructions are executed/processed • ALU performs the logical/arithmetic calculations 	2	<p>MP4 BOD carried out etc. for executed.</p> <p>Ignore inaccurate references to registers and components (other than MP2 correct example of a register).</p> <p><u>Examiner's Comments</u></p> <p>Candidates often correctly identified that data is fetched from memory, or from RAM, and are then processed. Some candidates gave a more technical description including the role of the registers in this process. The stronger responses included clear references to data or instructions being processed. Some candidates inaccurately identified that information was processed, or that programs were fetched from memory.</p>
	b		<p>1 mark for naming register, 1 for matching purpose</p> <ul style="list-style-type: none"> • Program counter / PC • Stores the address of the current/next instruction to be fetched / stores the address of the instruction for the current/next FE cycle • Memory address register / MAR • Stores the address of the current/next instruction/data to be fetched / stores the address where data/instruction is to be stored • Memory data register / MDR 	4	<p>Careful that the purpose is not an action such as fetches, takes, retrieves.</p> <p>Read full purpose and award a correct point</p> <p>Accept</p> <ul style="list-style-type: none"> • Current instruction register/CIR/Instruction register/IR • Stores the instruction currently being executed <p>BOD memory buffer register for MDR.</p>

		<ul style="list-style-type: none"> • Stores the data/instruction fetched from memory / stores data/instruction to be stored in memory / stores the data/instruction located in the memory location in the MAR • Accumulator / ACC • Stores the result of calculations / stores data currently being processed / by example / stores the result from the ALU 		<p>If there is no register but the register is given in the purpose column, award the purpose if accurate. If the answer in the register column is incorrect, do not mark purpose.</p> <p>For PC and MAR, accept 'pointer' for storing address</p> <p>Accept memory address, memory data</p> <p><u>Examiner's Comments</u></p> <p>Candidates were often able to identify one or two registers that are used in the F-E cycle. Fewer candidates were able to give a purpose in the F-E cycle.</p> <p>Some candidates identified that the registers were involved in the fetching or transmission of data, for example that the MAR transmits the address to RAM..</p> <p> Misconception</p> <p>A common misconception is that the program counter keeps track of how many programs have run or counts the instructions that are being processed.</p>
	c	<p>1 mark each to max 3</p> <ul style="list-style-type: none"> • Clock speed • Cache size • Number of cores 	3	<p>'clock' 'cache' 'speed' 'cores' on its own is NE.</p> <p><u>Examiner's Comments</u></p> <p>Candidates were often able to identify at least one characteristic of a CPU, most</p>

					commonly the clock speed and number of cores. Some responses were not precise enough as to the characteristics, for example stating 'clock' or 'core' without reference to the speed of the clock, or the number of cores, which were too ambiguous.
			Total	9	
2			<p>1 mark each to max 3</p> <ul style="list-style-type: none"> • Has a specific purpose / it only performs one/limited task / dedicated to the Follow Me system • Built within a larger device/car • Dedicated/specific/its own hardware / sensors • Has a microprocessor • Built-in operating system/software / software is all in firmware/ROM • ... it's instructions/operation does not/is hard to change/update • It is a control system / it is automated 	3	<p>MP2 BOD reference to it being 'built into' 'something' reasonable</p> <p><u>Examiner's Comments</u></p> <p>This question required candidates to apply their understanding of embedded systems to a different system.</p> <p>Candidates were often able to identify the key features of embedded systems that were relevant to this scenario. The most common points being that the system has a single purpose. Some candidates also identified that the system is built within a larger system, being the car.</p> <p>Fewer candidates were able to provide a third point. Those that did most commonly identified the dedicated hardware or gave an example such as the sensors are only providing data for this system.</p>
			Total	3	
3			<p>1 mark for example: e.g.</p> <ul style="list-style-type: none"> • Auto lights • Auto window wipers • Sat nav / GPS • Airconditioning / climate control 	3	<p>Allow anything that could be reasonably within a car. If example is not clear if it's an embedded system, read explanation for justification e.g. hazard lights – could be embedded if they are activated automatically when</p>

			<ul style="list-style-type: none"> • Radio/entertainment/infotainment system/media system • Lane assist • Engine management system • Auto-park • Cruise control • Auto-brake • Follow-me • Dashcam <p>1 mark each to max 2 for explanation.</p> <ul style="list-style-type: none"> • Limited functions / by example e.g. the system only checks the light and turns lights on/off • Dedicated microprocessor / by example e.g. there is a microprocessor that is only checking the lights • Hard to change function / by example e.g. the user cannot make the light system do any other role 		<p>the car crashes. Award the example in the explanation if this occurs.</p> <p>If justification is generic features of an embedded system max 1 for explanation.</p> <p>Do not award 'built into the car/larger machine' because this is in the question.</p> <p><u>Examiner's Comments</u></p> <p>This question required candidates to consider embedded systems within a car.</p> <p>There were a range of possible systems, the most common being GPS or satellite navigation systems. Other common responses included automated lights, automated wipers, and parking sensors.</p> <p>The most common explanation was that the system has a single (or limited) purpose, but few candidates expanded beyond this. Some candidates repeated that it was built into the car but this was provided in the question.</p> <p>Some candidates provided examples of embedded systems such as a washing machine, a microwave and a fridge/freezer. This was not appropriate to the context of the question.</p>
			Total	3	
4			1 mark for each term or definition	4	Read whole answer for CU and award correct point at any stage.

			<table><tr><th>CPU component or register</th><th>Definition</th></tr><tr><td>Program Counter / PC</td><td>Stores the address of the next instruction to be fetched from memory. Increments in each fetch-execute cycle.</td></tr><tr><td>CU (Control Unit)</td><td>(Sends signals to) synchronise / control / coordinates the processor/hardware/F-E cycle/processes/flow of data / decodes instructions (in CIR) / runs F-E cycle</td></tr><tr><td>Memory Address Register / MAR</td><td>Stores the address of the data to be fetched from, or the address where the data is to be stored.</td></tr><tr><td>Arithmetic Logic Unit / ALU</td><td>Performs the mathematical and logical calculations.</td></tr></table>	CPU component or register	Definition	Program Counter / PC	Stores the address of the next instruction to be fetched from memory. Increments in each fetch-execute cycle.	CU (Control Unit)	(Sends signals to) synchronise / control / coordinates the processor/hardware/F-E cycle/processes/ flow of data / decodes instructions (in CIR) / runs F-E cycle	Memory Address Register / MAR	Stores the address of the data to be fetched from, or the address where the data is to be stored.	Arithmetic Logic Unit / ALU	Performs the mathematical and logical calculations.		<p>CU ‘sends signals to components’ is not enough, it isn’t saying what the signal’s purpose is</p> <p><u>Examiner’s Comments</u></p> <p>This question required candidates to consider the definitions and identify the component or register that was being defined, as well as giving a definition for the CU.</p> <p>The ALU was often correctly identified.</p> <p>Common errors included giving MAR for the first definition in place of the PC and then following on with the MDR for the third row because the MAR had already been given by the candidate.</p> <p>Many candidates demonstrated a good understanding of the CU, most commonly identifying that it controls the flow of data, that it controls the FDE cycle or that it decodes instructions.</p> <div> Misconception</div> <p>A common error was stating that the Control Unit actually performs the FDE cycle, or that it executes the instructions.</p>
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			Total	4											
5	a	i	1 mark for correct ticks and gaps on each row	4	If extra ticks on each row, 0 marks for that row										

			<table> <tr> <th>Statement</th><th>MAR</th><th>MDR</th><th>Cache</th><th>Program Counter</th><th>RAM</th></tr> <tr> <td>It stores a single address</td><td>✓</td><td></td><td></td><td>✓</td><td></td></tr> <tr> <td>It stores frequently used instructions</td><td></td><td></td><td>✓</td><td></td><td></td></tr> <tr> <td>It is a register</td><td>✓</td><td>✓</td><td></td><td>✓</td><td></td></tr> <tr> <td>It stores all currently running data and instructions</td><td></td><td></td><td></td><td></td><td>✓</td></tr> </table>	Statement	MAR	MDR	Cache	Program Counter	RAM	It stores a single address	✓			✓		It stores frequently used instructions			✓			It is a register	✓	✓		✓		It stores all currently running data and instructions					✓		
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		ii	1 mark for register e.g. accumulator 1 mark for description e.g. stores the result of arithmetic operations	2																															
		b	1 mark per bullet <ul style="list-style-type: none"> • faster/higher clock speed • 3.2GHz will run more Fetch-Execute (F-E) cycles per second • ...therefore the more instructions can be executed per second / by calculation 	2																															
			Total	8																															
6			1 mark for each completed term Embedded systems have limited functions . They are often built into a larger machine. Two examples of embedded systems are a washing machine and automated lights in a car.	4																															
			Total	4																															

7	a	It has more cores.	1 (AO2 1a)	<p>Although Computer 1 has a lower clock speed than the CPU in Computer 2 it has more cores, which means that it can be faster than Computer 2.</p> <p>Any answer relating to splitting a program into processes that be carried out consecutively will be accepted.</p>
	b	RAM SSD HDD Graphics card (GPU)	2 (AO2 1a)	<p>Marks can be awarded for other appropriate responses:</p> <p>e.g. Motherboard Sound card</p>
	c	<ul style="list-style-type: none"> • data is transferred faster (1)... • ...which makes a CPU more efficient (1) • It is faster to transfer to and from cache (1)... • ...than transferring to and from RAM (1). 	2 (AO2 1a)	<p>1 mark to be awarded for each correct identification and 1 mark to be awarded for the associated explanation to a maximum of 2 marks.</p>
	d	<ul style="list-style-type: none"> • An instruction is fetched from memory • The instruction is then decoded • The decoded instruction is then executed so that the CPU performs continuously • The process is repeated • The program counter is incremented • The instruction is transferred to the MDR • The address of the instruction to be fetched is placed in the MAR 	2 (AO1 1a)	<p>1 mark to be awarded for each correct answer to a maximum of 2 marks.</p>
		Total	7	