

Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1			1 mark for: - Reduced hardware is needed on computers / reduced hardware costs - Improved security by keeping all software running from one physical device - Easier/cheaper to manage as only one physical device runs the programs. - Can add/remove resources/memory/processes to the VM - If it is infected by malware it can be deleted and recreated / the rest of the system isn't affected/is protected against malware - No direct access to hardware - Resources can be used more flexibly between the machines	1	<u>Examiner's Comments</u> There were some good responses to this question with many giving the response that Malware would not affect the server. Some talked about being able to try out different operating systems which was not relevant to this scenario.
			Total	1	
2	a	i	2 marks from each group to max 4: - Resource/memory management e.g. - Moving data between RAM and secondary storage/ virtual memory / paging and/or segmentation - Allocating/deallocating memory - Manage hardware/peripherals e.g. - Tracking all devices connected to the system - Device drivers - File management e.g. - Storing files in secondary storage - Searching for /copying / moving / renaming files/folders	4	DNA handle interrupts or manage scheduling. Allow any reasonable description that matches with the role. Mark in groups. <u>Examiner's Comments</u> This was generally well answered and the majority of candidates could give two roles. Less successful candidates were then unable to follow through with a reasonable description. More successful candidates were able to give two roles plus relevant and correct descriptions. Some described scheduling and interrupts which were given in the question and gained no marks.

			• Security/user management e.g. • Controlling who can access the system /Managing user profiles • Controlling who can access certain resources on the system / Managing access rights • Provide a user interface e.g. • Allowing the user to interact with the software/hardware/computer • Providing utilities e.g. • Used to monitor / manage / maintain the computer • To manage the security • Providing a platform on which to run software e.g. • Allows additional software to be installed on the computer • To allow the user to complete additional tasks														
		ii	1 mark for each correct match. <table><thead><tr><th>Scheduling Algorithm</th><th>Description</th></tr></thead><tbody><tr><td>Round Robin</td><td>Splits processes into different priority queues based on the amount of processor time they need. It allows them to move between the queues as their characteristics change.</td></tr><tr><td>First come first served</td><td>Selects the process that takes the shortest amount of time to complete. The processes are run until they are fully complete.</td></tr><tr><td>Multi-level feedback queues</td><td>Each process is allocated a fixed amount of CPU time. If the process is not complete it will be suspended and the next process will start.</td></tr><tr><td>Shortest job first</td><td>Each process is given equal priority and they are processed in the order they arrive.</td></tr><tr><td>Shortest remaining time</td><td>Selects the process that takes the shortest amount of time. The process can be suspended if another shorter process is added.</td></tr></tbody></table>	Scheduling Algorithm	Description	Round Robin	Splits processes into different priority queues based on the amount of processor time they need. It allows them to move between the queues as their characteristics change.	First come first served	Selects the process that takes the shortest amount of time to complete. The processes are run until they are fully complete.	Multi-level feedback queues	Each process is allocated a fixed amount of CPU time. If the process is not complete it will be suspended and the next process will start.	Shortest job first	Each process is given equal priority and they are processed in the order they arrive.	Shortest remaining time	Selects the process that takes the shortest amount of time. The process can be suspended if another shorter process is added.	5	<u>Examiner's Comments</u> Generally well answered and most candidates gained full marks. Those that did not tended to confuse shortest remaining time with shortest job first but were still able to gain three marks.
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b	i		1 mark per bullet to max 3: • Contains the computer start up instructions • Loads settings/configuration (CMOS/NVRAM) • Initialises/checks hardware/peripheral devices are available/work / carry out a POST check... • ...and reports errors • Determines the drive on which the OS is stored • Finds/loads the bootstrap/operating	3	DNA 'boots up' on its own <u>Examiner's Comments</u> Many candidates were able to gain at least one or two marks for saying the BIOS finds/loads the operating system and/or checks hardware.												

			system/kernel (into main memory)		
		ii	Mark from one group to max 2: - Storing firmware/ config/ operation instructions/ operating system/ device drivers... ...that can't be overwritten / doesn't need to be updated ...so that access is faster OR - Storing security settings/encryption keys/digital signatures... ...that must be maintained/can't be changed OR - Could be used as <u>primary</u> storage... ...so no need to load programs into memory ...so would save time loading up the program OR - Could be used as <u>secondary</u> storage... so the device will not need additional storage... to reduce the size of the device	2	<u>Examiner's Comments</u> Strong candidates were able to give a use such as store the operating system and an advantage. Many though, gave a very good description of what ROM is but did not give a different use and so were unable to gain any marks. A few candidates said it could store the BIOS which had already been given in the question. A few candidates talked about microwaves and washing machines which was not relevant to this scenario
			Total	14	
3	a	i	- Allows for more efficient use of computing resources ... Less likely to have workstations run idle ... can allocate more resources to power users dynamically Or	AO2.1 (2)	Accept other valid reasons with a suitable justification <u>Examiner's Comments</u> This question was generally not answered well. Candidates did not make sure that their responses were specific to thin clients.

			- Thin clients are cheaper than desktops... ...which could save the school money. Or - Thin clients are often physically smaller than desktops... ...allowing more desk space/workspace for staff/students.		
		ii	- Can cause network overload... ...if the network does not have sufficiently good bandwidth - Could create process lag... ...If lots of large processes run at the same time - If a virtual machine hangs/crashes the user is unable to reset it... ...whereas they can physically reboot on a local machine. - Thin-clients may not be compatible with some peripherals... ...meaning some of the school's peripherals become unusable.	AO2.1 (2)	Mark in pairs <u>Examiner's Comments</u> As with Question 3 (a) (i), candidates did not make sure that their responses were specific to thin clients and therefore lost marks.
	b		Multi Tasking is optimised to deal with multiple processes simultaneously/concurrently ...Can run multiple programs/tasks at the same time Example, e.g. - Home/personal computer Distributed Designed to run the same task over multiple machines Example, e.g.	AO1.1 (3) AO1.2 (3)	1 mark for type of OS 1 mark for description 1 mark for suitable example Allow other suitable types of operating system. <u>Examiner's Comments</u> This question was generally answered well, although some candidates were too vague in their descriptions of real time and distributed operating systems in particular. Exemplar 2

			• SETI or other cloud-based processes/ Clusters of desktops used for rendering/calculations. • Embedded ... • ... Will have a restricted set of operations (to conserve resources) • ... is read only Example, e.g. • Domestic appliance such as a washing machine • Real-Time ... • ...optimised to handle and respond to inputs with no wait/within a guaranteed response time/immediate. Example, e.g. • Used in “mission critical” systems such as aircraft control.		TYPE 1 Description ... real-time operating system, which is used when a response is required within a guaranteed time frame Example ... intensive game units for use when parameters need immediate assistance / immediate TYPE 2 Description ... embedded system, which is stored in the BIOS and has limited functionality, as it is used to perform specific tasks Example ... a device monitoring programme, as it is interacting directly with the hardware The candidate has been given full marks for this response as they have been clear that real time operating systems respond in a guaranteed time frame, with a suitable example of their use. Some candidates were too vague in their response for descriptions of a real time operating system with answers such as ‘responds quickly’.												
			Total	10													
4	a		<table><thead><tr><th>Statement</th><th>True</th><th>False</th></tr></thead><tbody><tr><td>BIOS stands for Boot Input Output Standard</td><td></td><td>✓</td></tr><tr><td>The BIOS can be used to alter hardware settings, such as which storage device the computer boots from.</td><td>✓</td><td></td></tr><tr><td>BIOS settings are stored in RAM</td><td></td><td>✓</td></tr></tbody></table>	Statement	True	False	BIOS stands for Boot Input Output Standard		✓	The BIOS can be used to alter hardware settings, such as which storage device the computer boots from.	✓		BIOS settings are stored in RAM		✓	3	1 mark per row. <u>Examiner’s Comments</u> This question was generally well answered by candidates.
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	b		• Stored away from the computer(s)/remote... • ... so in case of disaster, data is not also damaged • All of the data (from multiple machines) can be backed up at the same time • Can be accessed from elsewhere / other machines	2	Allow multiple interpretations of virtual storage (e.g. cloud / devices not connected directly to the computer) Do not allow space on its own or memory for storage <u>Examiner’s Comments</u>												

			- Storage can be expanded as necessary/no limit on size - Speed of access is not a priority for a backup - Can make recovery from another site easier - No physical space needed for backup hardware - No on site maintenance required - Allows more local storage capacity for data		Candidates who understood that virtual storage would be remote/not stored on the business premises were able to gain full marks on this question. Some candidates confused virtual storage with virtual memory and some did not understand that although it may be cloud storage it is still stored on a physical medium somewhere.
	c	i	Real time	1	Correct answer only <u>Examiner's Comments</u> This question was generally well answered.
		ii	<u>Multi-tasking</u>... ...runs multiple programs at the same time <u>Multi-user</u>... ... allows multiple users at the same time (must be clear that candidate is not discussing an OS that simply has multiple accounts) <u>Distributed</u>... ...allows multiple computers to work together on a single task <u>Embedded</u>... ...has a dedicated/limited function ...is read-only / cannot be changed	6	Mark in pairs Allow real time if not given as previous answer Do not accept "runs on an embedded system" as expansion of embedded OS, this is NE. <u>Examiner's Comments</u> This question was generally well answered with Embedded, Distributed, Multi-User and Multi-Tasking being the most common answers. Some candidates struggled to name and a type of operating system. Centres should advise candidates that OS brand names are not accepted as a type.
	d		- Interrupt checked for at start/end of each fetch-execute cycle - If the interrupt is of a lower/equal priority to the current process then the current process continues (If interrupt raised) contents of registers copied to stack	3	<u>Examiner's Comments</u> Many candidates were able to gain full marks on this question. Unfortunately, some candidates showed a lack of detail in their answers. Some candidates talked about interrupts being run during an FDE cycle or assumed that an interrupt would be

		- Flags are set to determine if interrupts are enabled / disabled - Program counter changed to point to <u>Interrupt Service Routine (ISR)</u> / <u>ISR</u> runs - After interrupt complete, previous register values restored back from stack - Flag is reset - If higher priority interrupt received during servicing of interrupt... ...this is added to stack and new interrupt dealt with		run immediately with no reference to priorities.  OCR support Resources for operating systems and interrupts can be found in this document. https://www.ocr.org.uk/Images/253685-the-function-and-purpose-of-operating-systemsdelivery-guide.pdf
e		Mark Band 3 – High Level (7–9 marks) The candidate demonstrates a thorough knowledge and understanding of memory management carried out by operating systems. The material is generally accurate and detailed. The candidate is able to apply their knowledge and understanding directly and consistently to the context provided. Evidence/examples will be explicitly relevant to the explanation. The candidate is able to thoroughly assess the importance of memory management to an efficient and secure system. There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated. Mark Band 2 – Mid Level (4–6 marks) The candidate demonstrates reasonable knowledge and understanding of memory management carried out by operating systems. The material is generally accurate but at times underdeveloped. The candidate is able to apply their	9	<i>The following shows example content that may form part of a candidate's answer. It is not intended to be an exhaustive resource, nor should a candidate be expected to specifically cover any particular amount of this.</i> Knowledge (AO1) - Memory management means to ensure that RAM is used efficiently and not wasted - Removes data not needed anymore (garbage collection), frees up space and allocates memory to applications - Paging or segmentation may be used to split up memory - Paging uses fixed size divisions whereas segmentation uses varying size divisions - Paging is where memory is divided physically - Segmentation is where memory is divided logically - Virtual memory may be used when RAM is (almost)full to enable applications to continue to run Application (AO2) - If RAM is unavailable or full, applications cannot be loaded - Data transferred out of RAM into virtual memory to free up

		knowledge and understanding directly to the context provided although one or two opportunities are missed. Evidence / examples are for the most part implicitly relevant to the explanation. The candidate makes a reasonable attempt to assess the importance of memory management to an efficient and secure system. There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence. Mark Band 1 – Low Level (1–3 marks) The candidate demonstrates a basic knowledge of memory management carried out by operating systems; the material is basic and contains some inaccuracies. The candidate makes a limited attempt to apply acquired knowledge and understanding to the context provided. The candidate provides nothing more than unsupported assertions. Any discussion of the importance of memory management will be vague or lacking detail. The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear. 0 mark No attempt to answer the question or response is not worthy of credit		space and then transferred back again when needed • Also includes security so that data stored in memory is not vulnerable • Memory management is important for a well-running machine. If not, RAM would rapidly run out and fill up with unneeded data/instructions and so no new applications could run • Paging causes internal fragmentation whereas segmentation causes external fragmentation • A page table is used to map page location which is slower than a segmentation table • It is easier for the OS to manage page locations as they can be stored non-contiguously. Segments can be non-contiguous but work better contiguously Evaluation (AO3) • RAM is much more expensive than secondary storage (per unit/GB) so virtual memory is useful • rather than having to buy more RAM • Over use of virtual memory causes slow down and even disk thrashing if pages have to be swapped back and forth too often • Paging can be more effective because any free memory space can be used to swap data in and out whereas with segments, lots of space will sit unused until a segment the right size is available • Segmentation errors can cause memory leakage which would cause the system to crash • Security issues – applications can only access memory allocated to them so (for example) a malicious application cannot access the
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					memory allocated to a banking app. Also when applications are closed, data is removed before being reallocated so that applications cannot see historic data <u>Examiner's Comments</u> Many candidates were able to show an understanding of pages being a fixed size and segments being variable size, but few were able to relate virtual memory to the use of pages and segments and few had an understanding of how they are used. Responses to why it is important tended to be vague. There were a few candidates who talked about compression which was not relevant to the question.
			Total	24	
5			- A piece of software which allows hardware/device to communicate... ...with the operating system	AO1.2 (2)	<u>Examiner's Comments</u> This question was generally answered well. Some candidates were not given the second mark as they did not make reference to the operating system.
			Total	2	
6		i	- For printer queue - All documents/users have equal priority - Whichever document is received first is printed first - First in First Out / Last in Last Out	2	<u>Examiner's Comments</u> This question was generally well answered with many candidates gaining at least 1 mark. The question asked why the OS used 'first come first served' and many candidates were not given marks for stating why the user would want the OS to use it. Some candidates talked about other scheduling algorithms even though this was not relevant to the question.
		ii	- To enable <u>multitasking</u> to take place - To switch between active processes and those running in the background	3	BP4, 5 & 6 are dependent on BP3 only

			- To limit each process to a certain amount of time/allow processes an equal share of processor time.... ...to ensure the OS cycles through all processes / the process then goes to the back of the end of the queue ...so that users can receive an immediate response ...to handle an interrupt immediately		
		iii	- Shortest job first / shortest remaining time - Process which has the shortest <u>time</u> (remaining) is completed first - Multilevel feedback queues - Uses <u>queues</u> with different priorities - Jobs can be moved between <u>queues</u>	2	One mark for name, one mark for description.
			Total	7	
7	a	i	1 mark for any of the following points, e.g: - GUI will need to remove open file manager windows - OS will need to remove open files/release locks - Inform the CPU to cease transferring files	1 (AO2.1) (1)	Allow other suitable alternative answers. <u>Examiner's Comments</u> Very few candidates achieved a mark here. Many mentioned that the CPU would be busy but were not specific enough to gain the mark. In questions of this type, examples need to be specific to the question.
		ii	1 mark per bullet up to a maximum of 2 marks, e.g: - Stacks use LIFO/FILO storage - As processes are halted by an ISR they are pushed on the stack - When they are returned, they are popped from the top of the stack - So they are returned to in correct order	2 (AO1.2) (2)	<u>Examiner's Comments</u> Few candidates gained both marks for this question. The concepts of pushing and popping items was mentioned by many candidates although this was often too vague and didn't link to the question. Candidates needed to use the correct terms for accessing items from a stack to gain the marks in this question.

	b		1 mark per bullet up to a maximum of 2 marks, e.g: • Stored in ROM • Tests hardware/components (are working) • Boots up the operating system	2 (AO1.2) (2)	Accept description of POST/Power On Self Test for BP2 Accept loads up instead of boots up (BP3) <u>Examiner's Comments</u> This was generally answered well, although some candidates were vague in their response. The concept of the BIOS booting up the Operating System was missed by some, but most candidates mentioned the BIOS checking that the hardware is operational (POST). <u>Exemplar 1</u> <i>Basic input output system, responsible for the power on self test (POST) which checks memory and power units are working correctly. Used to call the bootstrap, which will load the operating system.</i> Exemplar 1 was given full marks. The candidate achieved the first mark for being clear that the BIOS checks hardware and has provided a suitable example. The second mark has been awarded for explaining that the BIOS loads the operating system. Although it was not essential to mention POST (Power-On-Self-Test) this is useful to explain the process that occurs.
	c	i	1 mark for any of the following bullet points: • Round Robin • Multi-level feedback queues • Shortest job first • Shortest time remaining	1 (AO1.1) (1)	Do not Allow: • First come First Served <u>Examiner's Comments</u> Round Robin was the most popular answer by far. Most candidates achieved the mark although some used the example in the question. Candidates should be reminded to read the questions carefully here and to not repeat answers already provided.
		ii	1 mark per bullet up to a maximum of 2 marks, e.g: • Jobs dispatched on a FIFO basis	2 (AO2.1) (2)	Accept processed instead of dispatched (Bp1) Do not accept task/data instead of jobs (BP1 to 3)

			- Each job/packet is equal priority - Each job/packet switch has the same processing time		Examiner's Comments Few candidates achieved both available marks and most missed the concept of jobs/packets having equal priority.
	d		1 mark per bullet up to a maximum of 2 marks, e.g: - Paging uses physical addressing.... Segmentation uses logical addressing - Paging uses fixed size memory blocks.... Segmentation uses variable length memory blocks	2 (AO1.2) (2)	Answer must cover paging and segmentation for 2 marks. Do not accept data instead of memory Examiner's Comments To get both marks, candidates need to be clear that paging and segmentation are about allocating memory. Many candidates were not clear on this and discussed managing data or packets. Candidates should be careful to use the correct terminology for questions of this type in particular.
			Total	10	
8	a		e.g. - Encryption ...scrambles meaning of data files with a key - Defragmentation ...organises file segments on secondary storage - Compression ... reduces size of files - Backup ...makes regular copies of files in case of loss - Disk Checker	4 AO1.1	Mark in pairs, 2 marks per example. Accept other sensible examples of utility software.
	b	i	- Paging ...blocks of memory of equal size / fixed size - Segmentation ...blocks of memory split logically /variable size	4 AO1.2	
		ii	e.g. Security	2 AO1.2	

			• ...does not let programs access memory reserved for other programs. • Multitasking • ...allows multiple programs to run at once		
		iii	• (Currently unneeded) pages moved from memory to secondary storage • ...to create room in memory • pages moved back to memory when required	2 AO1.1	
	c		• Software/program • ...that allows the operating system to communicate with hardware Examples: • Printer driver • Webcam driver • Sound card driver • Graphics card driver etc.	3 AO1.1 (1) AO2.1 (2)	Max two for description, Max one for example
			Total	15	
9	a		1 mark per bullet up to a maximum of 3 marks, e.g.: • Peripheral management • Handle interrupts • File management • Provides a user interface • Provides platform to install and run software. • Provides utilities for system maintenance. • Allows multi-tasking • Provides security	2 AO1.1 (2)	Do not accept memory management or processor scheduling.
	b		1 mark per bullet up to a maximum of 2 marks, e.g: • Programs/data can be held in non-contiguous memory locations (using virtual addressing)... • ...making it easier to make best use of remaining storage/ to avoid having to move	2 AO1.2 (2)	

			content around to fit in new programs. • It allows pages to be transferred to and from secondary storage (i.e. virtual memory). • As random access there is no performance drop vs sequential storage		
	c		1 mark for stating an initial reason and 1 mark for suitable expansion for each (4 marks total), e.g.: • Faster read/write times... • ... allows Julie to complete her work quicker • More portable/durable... • ... allows Julie to be mobile between home and university • Lower power consumption... • ... Allows Julie to use all through the day without recharge • Quieter running ... • ... Allows Julie to use her laptop during lectures without disturbing people/lecturer	4 AO2.1 (4)	Maximum of 2 marks for each reason. Expansion points must be relevant to the scenario stated in the question. Accept reliable for durable on BP3
	d		1 mark for any of the following bullet points: e.g. • Disk Defragmentation • System Clean-up • Anti-Virus/Malware • Firewall • File management • Disk Drivers	1 AO1.1 (1)	
			Total	9	