GCST

1.2.1
OPERATING SYSTEMS
TOPIC WISE EXAM QUESTIONS
ANSWERS

A-LEVEL OCR

1	(e)	(ii)	• Multi-tasking… • …runs multiple **programs at the same time** • Multi-user… • … allows multiple **users at the same time** (must be clear that candidate is not discussing an OS that simply has multiple accounts) • Distributed… • …allows multiple computers to work together **on a single task** • Embedded… • …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.
1	(f)		• 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 • Flags are set to determine if interrupts are enabled / disabled • Program counter changed to point to Interrupt Service Routine (ISR) // ISR 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	3	
1	(g)		**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 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.	9	*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.* **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 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

			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 marks** No attempt to answer the question or response is not worthy of credit		• 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 memory allocated to a banking app. Also when applications are closed, data is removed before being reallocated so that applications cannot see historic data

AS - Level

1	**(d)**		• A piece of software which allows **hardware/device to communicate**… • …with the **operating system**	AO1.2 (2)	

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2022

6	(a)	(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	
		(ii)	• To enable multitasking to take place • To switch between active processes and those running in the background • 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	3	BP4, 5 & 6 are dependent on BP3 only
		(iii)	• Shortest job first / shortest remaining time • Process which has the shortest time (remaining) is completed first • Multilevel feedback queues • Uses queues with different priorities • Jobs can be moved between queues	2	One mark for name, one mark for description.

AS - Level

1	(a)		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)
1	(b)	(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
1	(b)	(ii)	1 mark per bullet up to a maximum of 2 marks, e.g: • Jobs dispatched on a FIFO basis • Each job/packet is equal priority • Each job/packet switch has the same processing time	2 AO2.1 (2)	Accept processed instead of dispatched (Bp1) Do not accept task/data instead of jobs (BP1 to 3)
1	(c)		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
1	(e)	(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.
1	(e)	(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)	

GCSE

2020

9	(a)	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 • …does not let programs access memory reserved for other programs. • Multitasking • ...allows multiple programs to run at once	2 AO1.2	
		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	
	(b)		• 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

AS - Level

2	(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.
2	(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 content around to fit in new programs.	2 AO1.2 (2)	

	b		– System software/software used to manage the device – Which is built into the device itself – Stored in the device's ROM/cannot be changed – Specific to the hardware/purpose (1 mark per -, max 2)	2 AO1.1	
	d		- Allows them to run the update on a number of different systems/OSs - …without needing multiple physical machines. - They can put viruses on the VM to test if the update can catch them - …but protect the physical machine from the virus/the VM can quickly be reset to its original state. (1 per -, Max 3)	3 AO2.2	
	e		– FCFS means jobs are completed in the order they arrive – ineffective in catching viruses/the virus may run first – …the virus checker may never run/take a long time to start running – the virus checker may be continuously running… – …this will temporarily stall the system/ all other processes have to wait. (1 mark per -, max 2)	2 AO2.2	
	f		– The computer would not be able to boot/load the OS – Or set up its initial configuration/hardware checks – Making the computer unusable (1 mark per -, max 2)	2 AO2.1	

AS - Level

	d		- Provide a user interface - Provide System Security - Manage hardware - Provide utilities - Provide a platform from which software can be installed/run - Schedule jobs - Handle interrupts - Manage memory (1 per - , max 3)	3 (AO1.1)	

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2018

2	a	i	- Provide a (user) interface - Manage hardware/peripherals - Manage CPU usage / handles interrupts - Provide security - Provide platform to run other software - Provide utilities for system maintenance (1 Mark per -, Max 3)	3 (AO1.1)	If candidate names utility software, allow BP6
		ii	Paging	1 (AO1.1)	
		iii	- Operating system uses area of secondary storage as virtual memory. - Move unused pages/parts (of program A and/or B) into virtual memory - Load program C into (physical) memory. (1 Mark per -, Max 3)	3 (AO2.1)	
7	a		- Needs to be able to respond instantly to changes… - …such as someone stepping in front of car (or other sensible example) - RTOS offers a guaranteed response time. - A non RTOS might be busy dealing with other tasks and not respond until it is too late.	3 (AO1.2)	

AS - Level

1	a		<table><tr><td>Operating system</td><td>Tick One</td></tr><tr><td>Distributed</td><td></td></tr><tr><td>Embedded</td><td>✓</td></tr><tr><td>Multi-user</td><td></td></tr></table>	**1 AO2.1 (1)**	
	c	i	- A program/software - That controls a piece of hardware - Providing an interface/bridge between the device and (operating) system *(1 per -, max 2)*	**2 AO1.1 (2)**	
3	a		- The CPUs can work in parallel - … on the same problem - try multiple keys simultaneously… - …to break the code (1 per -, max 2)	**2 AO3.3 (2)**	
4	a		- The BIOS is loaded/ carries out its checks - the BIOS/bootstrap loads up the OS. (1 per -, max 2)	**2 AO2.1 (2)**	

c		**Mark Band 3–High Level (7-9 marks)** The candidate demonstrates a thorough knowledge and understanding of how OSs manage resources (for this band these should be reference to CPU time and memory); Strong evaluation of different approaches. The candidate provides a thorough discussion which is well-balanced. Evaluative comments are consistently relevant and well-considered. There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated. Candidate has used appropriate technical terminology throughout. There are few if any spelling errors or errors of grammar. **Mark Band 2 –Mid Level (4-6 marks)** The candidate demonstrates reasonable knowledge and understanding of how OSs manage system resources (for 5+ Marks there should be reference to both CPU time and memory). The candidate provides a reasonable discussion, the majority of which is focused. Evaluative comments are for the most part appropriate, although one or two opportunities for development are missed. There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence. There may be spelling errors or errors of grammar in the response but they are not obtrusive.	**9** **AO1.1** **(2)** **AO1.2** **(2)** **AO2.1** **(2)** **AO3.3** **(3)**	**AO1** Memory management divides memory either by paging or segmentation. Virtual memory is where part of secondary storage is treated as extra memory space. It is used when physical memory space is limited. CPU time is allocated to processing using scheduling. Schedulers use different algorithms. When CPU attention is needed interrupts are generated. **AO2** Paging divides memory by fixed size physical divisions. Whilst all pages are the same size, what that size is can vary. Segmentation is dividing memory according to variable size logical divisions. Scheduling algorithms include Round Robin (Each job gets a fixed time slice), First Come First Served (The first job to arrive is processed until completion, then the next…), Shortest Job First (The quickest to complete job is finished first), Shortest Remaining Time (quickest job is completed first but stops and re-evaluates when a new job arrives), Multi-Level Feedback Queue (Jobs are put in different queues depending on their importance). Interrupts are signals sent to the processor asking for attention. **AO3** With segmentation only the exact space needed is used per program, however as programs are loaded and removed from memory there may be wasted space between programs. Programmers often need to specify segments.
		Mark Band 1-Low Level (1-3 marks) The candidate demonstrates a basic knowledge of how OSs manage system resources The candidate makes a limited attempt to apply acquired knowledge and understanding to the context provided The candidate provides a limited discussion which is narrow in focus. Judgments if made are weak and unsubstantiated. 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. There are likely to be spelling errors and/or errors of grammar, which will disrupt the flow of the response **0 marks** No attempt to answer the question or response is not worthy of credit.		The fixed size of pages make it easier to allocate pages and work out their position. Space inside a page may be 'wasted' as program is unlikely to take up exact number of pages, however all pages can be used with no wasted space between them. Programmer need not worry about the pages. In practice both are used in conjunction (e.g. segmentation on top of paging). Some scheduling algorithms (e.g. SJF, STR) can cause starvation (i.e. certain jobs never get processed). More complicated scheduling algorithms take up lots of processor time for the scheduling itself, taking away processing time from the actual jobs that need processing. Interrupts mean that the processor only has to worry about being needed when told (as opposed to having to constantly check i.e. polling).

8			**Mark Band 3–High Level (7-9 marks)** The candidate demonstrates a thorough knowledge and understanding of how VMs can be used (for full marks they have identified 2 realistic uses of VMs); Thorough discussion of pros and cons of VMs. 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 provides a thorough discussion which is well-balanced. Evaluative comments are consistently relevant and well-considered. There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated. Candidate has used appropriate technical terminology throughout. There are few if any spelling errors or errors of grammar. **Mark Band 2 –Mid Level (4-6 marks)** The candidate demonstrates reasonable knowledge and understanding of how a VM could be used and their pros and cons. Evidence/examples are for the most part implicitly relevant to the explanation The candidate provides a reasonable discussion, the majority of which is focused. Evaluative comments are for the most part appropriate, although one or two opportunities for development are missed. There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence. There may be spelling errors or errors of grammar in the response but they are not obtrusive.	9 **AO1.1 (2)** **AO1.2 (2)** **AO2.1 (2)** **AO3.3 (3)**	*Points May Include:* **AO1** - A virtual machine is a piece of software that behaves in the same way as an actual computer. - In this case the VM on the computer would behave as though it were a games console. - Some VMs are used to interpret intermediate code. **AO2** - VMs of different consoles allow the program to be tested for different machines from the programmer's computer. - Saves space and the time and cost of setting up multiple systems. - Requires a powerful computer (as must run its own OS and the VM). - The VMs need to be accurate representations of the physical machine or the final code will not work on them. - Game could be written in a language that is interpreted to intermediate code and is run off a VM. - This means only one version of the code needs be written and it will run on all systems. - This saves time and maximizes profits. - However the game will run more slowly than if it had been compiled to native code. **AO3** - Using Virtual Machines may be a useful tool during testing, saving time. - Realistically physical machines will have to be used at some point to be 100% sure everything works as it should. - Using a VM to run intermediate code makes it easy to release for a variety of platforms. - But will be at the expense of game performance.

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2017

	b	i	Paging…(1) …Memory is divided into fixed/physical units(1) Segmentation… (1) …Memory is divided logically/variable size according to its contents. (1)	4 (AO1.1)	Accept same size units for MP1
		ii	Multitasking allows the user to run more than one program at the same time. (1) E.g. running CAD software whilst checking emails. (1)	2 (AO1.1 – 1 mark AO1.2 – 1 mark)	Accept any reasonable work related answer

2016 AS

1	a		**Any 2 from:** • Allow multiple computers/resources… (AO1.1) • …To be treated as one/work on the same problem (AO1.1) **1 from:** • Meaning all the computers can work on producing the same special effect. (AO2.1)	3 **AO1.1 (2)** **AO2.1 (1)**	

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EXTRA

1		i	The system gives a response within a guaranteed time frame (1).	1	For 1 mark.
		ii	• If something happens to a patient, a response must be immediate (1). • Other types of system may have delays in response (1). • This could result in a patient not receiving treatment in time (1).	2	Up to 2 marks for a valid explanation that demonstrates application of knowledge and understanding to given context.
			Total	**3**	
2	a	i	Once a job starts it prevents other jobs from being processed A job using a slow resource (eg printer) wastes processor time	2	**Examiner's Comments** This question seemed to baffle a lot of candidates who decided to answer a question about priorities instead. Those who answered the question properly generally managed to get one mark, there were relatively few who got full marks for this.
		ii	Round robin Time slice to each user in turn *Or* Length of job Shortest job first	2	One method only - marks in pairs Accept other examples, including Priorities Highest priority first **Examiner's Comments** This question was well answered by most candidates with "round robin" being the clear favourite response.
		iii	Process as many jobs as possible… …in least possible time / quicker Ensure all jobs are processed (fairly) Maximise number of interactive users… …with fast response times / real time Efficient use of resources / processor time	4	**Examiner's Comments** In general, this was well answered with the whole range of expected responses from the mark scheme being used.
	b		Organise the use of (main) memory… …by converting logical addresses to physical addresses Allows programs to share memory / allocate memory… …& protect programs / data from each other Allows programs larger than main memory to run	3	**Examiner's Comments** Most candidates gave correct responses to this, with the majority of those gaining two marks, the most popular answers for this were 'allocates memory' and 'protect programs from each other'.

	c		Partitioning memory Pages are fixed size Pages are physical divisions Used for virtual memory	3	cao **Examiner's Comments** A lot of candidates had problems with this question and a significant few thought that this was concerning saving to secondary memory. Very few mentioned "partitioning" and it was thought that this should be fairly standard when referring to paging.
4			– Complete the current FDE Cycle – Check the priority of the incoming interrupt. – If its of a higher priority than the current task. – Contents of registers stored in memory.. – … in a stack. – The relevant interrupt service routine is loaded … – ..by loading the relevant value into the program counter. – When the ISR is complete the previous state is popped from the stack – And are loaded back into the registers. (1 per –, max 6)	6	

If you found this useful, drop a follow to help me out!

THANK YOU!

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