Topic 2

Software and Software Development

1(a) A software development company is building an operating system for a mobile phone that is in the process of being designed.

Explain how the developers could use virtual machines.

[2]

(b) One of the developers is responsible for writing the code for what happens when the CPU receives an interrupt. Outline what the code must do.

[6]

2(a) A small manufacturing business uses networked computers with closed source application software installed.

Each computer the business uses has a BIOS.

Tick (✓) **one** box in each row to identify whether each statement in the table is true or false.

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]

(b) The business uses virtual storage to hold regular backups of all of its data.

Explain why virtual storage is well-suited for storing backups.

---

[2]

(c) One computer owned by the business monitors critical-safety features of manufacturing. All input data must be processed within a predictable timescale of a fraction of a second.

(i) State the type of operating system that should be used by this computer.

---

[1]

(ii) Give the name of **three** other types of operating system, and for each state its purpose.

Type 1 ---

Purpose 1 ---

Type 2 ---

Purpose 2 ---

Type 3 ---

Purpose 3 ---

---

[6]

(d) When a device such as a keyboard or printer requires attention from the CPU, an interrupt is raised.

Explain how an operating system deals with an interrupt.

---

[3]

(e) Memory management is a key function of an operating system. Explain how an operating system can manage the memory available to applications and why doing so is important.

You should include the following in your answer:

- the different actions carried out by an operating system to manage memory
- how memory that is being managed can be split up
- why memory management is important.

---

[9]

3 Arnold has several computing devices around his home. Each device has an operating system installed.

Arnold has a PC which has a Basic Input Output System (BIOS).

Describe what is meant by the term 'BIOS'.

[2]

4(a) Operating systems usually come with utility software pre-installed.

Give **two** examples of utility software, explaining the purpose of both.

1 ---

---

2 ---

---

[4]

(b) Operating systems make use of device drivers.

Define what is meant by the term 'device driver', giving one example of a device driver that a home user would need.

Definition ---

Example ---

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[3]

5 A company makes anti-virus software.

Anti-virus software is an example of a utility.

When running the anti-virus software, an operating system uses a scheduling algorithm to determine an allocation of CPU time to the anti-virus software.

Explain why a First Come First Served scheduling algorithm would **not** be suitable in this situation.

[2]

6 An operating system has to manage a system's resources.

One aspect of this is memory management.

(i) Describe **one** difference between paging and segmentation.

---

[2]

(ii) Explain how an operating system may overcome the problem of physical memory being full.

---

[4]

7 A small manufacturing business uses networked computers with closed source application software installed.

A spreadsheet application package is used to calculate employee's wages.

(i) Give **one** benefit of using a spreadsheet application for this task compared to calculating wages manually.

---

[1]

(ii) Give **two** other types of application packages that the small business could use, giving an example of a task that the business could use each application for.

Application 1 _____

_____

Example of task 1 _____

_____

Application 2 _____

_____

Example of task 2 _____

_____ **[4]**

(ii) Describe a drawback of using closed source software (rather than open source software) for the small business.

_____

_____

_____

_____

_____

_____ **[3]**

8 Describe **two** benefits of using an object-oriented paradigm rather than a procedural paradigm.

1 _____

_____

_____

_____

2 _____

_____

_____

_____ **[4]**

9 Sundip writes an algorithm to carry out addition and subtraction. The algorithm will use an initially empty stack with the identifier `numbers` and will take input from the user.

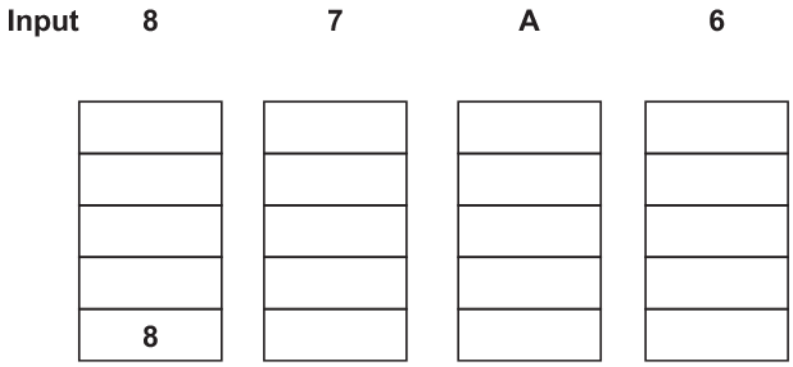
The action the algorithm takes depends on the value input by the user. These actions are listed in **Fig. 2**.

Value input	Action to take
A	• Pop two values from the `numbers` stack • Add the two values • Push the result back onto the `numbers` stack
S	• Pop two values from the `numbers` stack • Subtract the first popped value from the second • Push the result back onto the `numbers` stack
E	• Pop one value from the `numbers` stack • Output this value • End program
Any other value	• Push the input value to the `numbers` stack

Fig. 2

(i) Complete the diagram to show the state of the stack after each value is entered into the algorithm. The letters will complete an action stated in **Fig. 2**.

The state of the stack after the first value, 8, has been completed for you.



[3]

(ii) Complete the following table to give the output from this algorithm when the following set of inputs are entered by the user. The letters will complete an action stated in **Fig. 2**.

Input data (from left to right)	Output
9 3 A E	
10 5 A 8 S E	
25 5 S 2 3 A S E	

[3]

(iii) If the user enters **4 2 S A E** , the algorithm will not work correctly.

Explain what problem this input data will cause and why the problem occurs.

---

[3]

10 A computer system will contain several input and output devices.

Explain the role of device drivers when using input and output devices on a computer system.

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[2]

11 A program is amended to include the use of several queue data structures.

(i) Describe how an array can be used to implement a queue data structure.

---

[3]

(ii) * Discuss the use of object-oriented programming and procedural programming to create and manipulate the queue data structures.

You should include the following in your answer:

- the features of object-oriented programming
- the features of procedural programming
- the benefits of using object-oriented instead of procedural programming when creating several queue structures.

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[9]

12 * A programmer has been asked by a client to create a complex computer program. Compare the spiral model and waterfall lifecycle methodologies for this task.

You should include the following in your answer:

- how both methodologies could be used to develop a complex computer program
- the benefits of each methodology for this task
- the drawbacks of each methodology for this task.

[9]

13 Anika's computer runs a multi-tasking operating system. She has access to a printer and a broadband internet connection through a wireless connection. The operating system uses scheduling algorithms such as first come first served and round-robin.

(i) Explain why the computer's operating system uses a first come first served algorithm when sending documents to the printer.

[2]

(ii) Explain why the computer's operating system uses a round-robin algorithm for allocating processor time.

[3]

(iii) Describe **one** other scheduling algorithm.

[2]

14(a) For each statement shown in **Table 5**, tick (✓) **one** box in each row to indicate which stage of compilation each action takes place at.

	Lexical analysis	Syntax analysis	Code generation
Comments and whitespace are removed			
Keywords are replaced with tokens			
Object code is created			
Symbol table created for variables			
Builds an abstract syntax tree			

Table 5

[5]

(b) Describe the purpose of code optimisation.

---

[2]

15 A program is written using an object-oriented programming paradigm and uses a class called `video` to organise videos that are streamed to customers.

The class `video` has these attributes:

- name
- number of views
- star rating.

The constructor method will set the name attribute to the name that is passed in as a parameter. The constructor will also initially set the number of views to 0 and the star rating to 3.

(i) Write program code or pseudocode to declare the class `video` and initialise the required attributes as private.

You should include **both** the attribute definitions and the constructor method in your answer.

[7]

(ii) A public method called `updateviews()` will update the number of views after a video has been viewed. This method is defined inside the `video` class.

Write program code or pseudocode for the method `updateviews()` to increase the number of views by one.

[2]

16 A programmer creates this function shown in **Fig. 5** using a high-level language.

```
function mystery(x,y)
    total = x + y
    while x >= 10 then
        x = x - 10
        y = y - 10
        total = total + x + y
    endwhile
    return total
endfunction
```

Fig. 5

(i) State the value output by the line `print(mystery(10,20))`

---

[1]

(ii) State the value output by the line `print(mystery(0,70))`

---

[1]

(iii) State the value output by the line `print(mystery(45,55))`

---

[1]

17 **Fig. 1** shows assembly code written using the Little Man Computer (LMC). The program calculates and outputs the total amount that is donated to a charity in any particular day.
Depending on the amount, an additional bonus may be added to each amount donated.

```
start      INP
           STA donation
           SUB hundred
           BRP bonus
nobonus    LDA total
           ADD donation
           STA total
           OUT
           BRA start
bonus      LDA total
           ADD donation
           ADD twenty
           STA total
           OUT
           BRA start
hundred    DAT 100
twenty     DAT 20
donation   DAT 0
total      DAT 0
```

Fig. 1

(i) The program shown in **Fig. 1** is run **once** using **three** different inputs. Therefore, while the program is running once, it will output the updated total three times.

Give the total values that are output when the values **10**, **50** and **120** are input into this program.

Output for 10 _____

Output for 50 _____

Output for 120 _____

[3]

(ii) Write LMC code that will reset the value of the memory location labelled `total` to zero and then stop the program.

_____

[4]

(iii) This program is run on a processor that allows pipelining.

Define the term 'pipelining'.

[3]

(iv) Explain **one** benefit to a charity of using a processor that allows pipelining.

[2]

18 Ruhail will test his program code to make sure that it works correctly.

State **two** test strategies that Ruhail could use.

1 _____

_____

2 _____

_____

[2]

19 Charlie's computer has firewall utility software already installed.

Explain **two** other pieces of utility software that Charlie should install on her computer.

1 _____

_____

_____

_____

2 _____

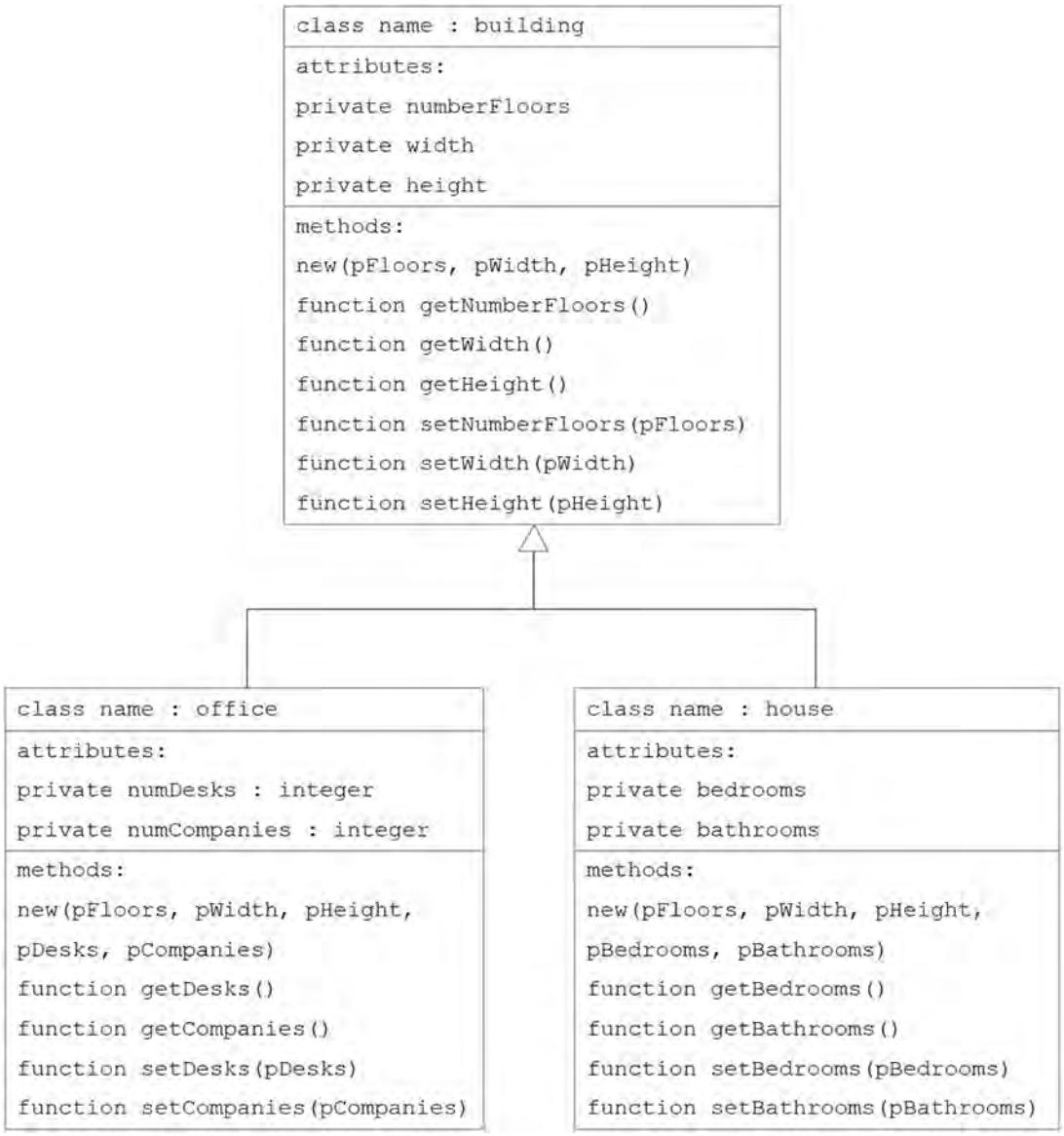
_____

_____

_____

[4]

20 Christoff is writing a program to simulate a city using object-oriented programming. He is designing classes to store different types of buildings and their location on the road. He has created the following plan for some of the buildings:



The method new is used to denote the constructor for each class.

State the purpose of the constructor.

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[1]

END OF QUESTION PAPER

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1</td><td>a</td><td></td><td>– Developers can run their operating system on a software implementation of the phone …
– … Until the physical machine is ready.
(1 per –)</td><td>2</td><td></td></tr>
<tr><td></td><td>b</td><td></td><td>– 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)</td><td>6</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>8</td><td></td></tr>
<tr><td>2</td><td>a</td><td></td><td><table><tr><th>Statement</th><th>True</th><th>False</th></tr><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></table></td><td>3</td><td>1 mark per row.

<u>Examiner's Comments</u>

This question was generally well answered by candidates.</td></tr>
</table>

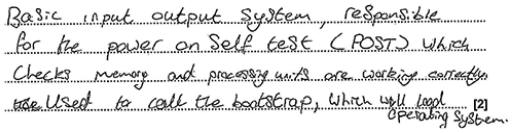
Question			Answer/Indicative content	Marks	Guidance
	b		• Stored away from the computer(s)/remote… • … so in case of disaster, data is not also damaged • All of the data (from multiple machines) can bebacked up **at the same time** • Can be accessed from elsewhere / other machines • Storage can be expanded 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	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> 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.

Question			Answer/Indicative content	Marks	Guidance
		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. Examiner's Comments 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 • 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	Examiner's Comments 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 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

Question			Answer/Indicative content	Marks	Guidance
	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 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

Question			Answer/Indicative content	Marks	Guidance
			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		• 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 memory allocated to a banking app. Also when applications are closed, data is removed before being reallocated so that applications cannot see historic data **Examiner's Comments**

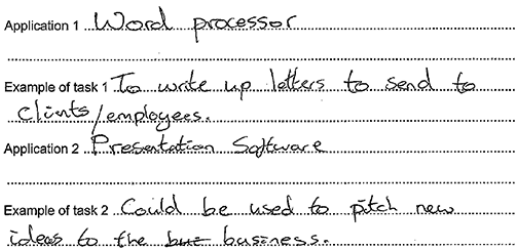
Question			Answer/Indicative content	Marks	Guidance
					Many candidates were able to show an understanding of pages being a fixed size and segments being variable size, but few were able to relate virtual memory to the use of pages and segments and few had an understanding of how they are used. Responses 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	

Question			Answer/Indicative content	Marks	Guidance
3			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). **Exemplar 1**  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.
			Total	**2**	

Question			Answer/Indicative content	Marks	Guidance
4	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		• 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	7	

Question			Answer/Indicative content	Marks	Guidance
5			– 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	Examiner's Comments Those candidates who demonstrated a clear understanding of 'First Come First Served' scheduling scored well on this question. Some candidates incorrectly referred to priorities and interrupts in their responses which gained no credit.
			Total	2	
6		i	Paging is fixed size / physical divisions (1) Segmentation is dividing memory logically (i.e. will be variable size). (1)	2	
		ii	Uses virtual memory (1) which is an allocated area of a hard drive/secondary storage device.(1) Pages that aren't needed are moved to VM (1) and moved back to physical memory when required (1)	4	
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
7		i	e.g. • **Fewer** mistakes (likely to be made) // **More** accurate • Faster as you can apply the same formula to multiple cells // By example • What-if analysis can be performed • Values can be changed and results **automatically(re)calculated** (by using formulas) • Can be shared electronically	1	Do not accept "faster" on its own without clarification of what/why it is faster. <u>Examiner's Comments</u> Candidates who had a good knowledge of software were able to gain the mark on this question although many gave answers like faster or easier without saying what made it faster or easier.
		ii	e.g. • Database/DBMS • …to store/query/sort data about customers/staff/stock • Word processor • …to create documents / letters / invoices for clients/staff • Presentation software • …to create presentations for clients/staff • Email software • …for staff to communicate with each other or with customers • Graphics manipulation • …to produce adverts / images for sales • Web browser • …to view websites to purchase materials/stock// view competitor's website	4	Mark in pairs – one mark for naming type of application software, one for the example. Application type must be correct to give example. Do not accept brand names for first mark but FT for example. Ignore brand names if description given after E.g. Outlook / Email application Accept other sensible application software (such as CAD, Desktop Publishing). Do not accept special purpose / bespoke / utility software. Do not accept spreadsheet (given in question) Example must be relevant to the business <u>Examiner's Comments</u> Many candidates were able to identify application packages and could give valid tasks that a business could use them for. Less successful candidates tended to give utility software or were not able to apply the use to the business.

Question			Answer/Indicative content	Marks	Guidance
					Exemplar 1  The candidate has correctly identified 2 different applications and given a valid use for a business.
		iii	• No access to <u>source code</u> • Cannot modify//improve to meet business needs • Cannot fix bugs • (Usually) cost to purchase licences // licenceconditions to meet//ongoing fees	3	Do not award a reverse of the mark point by describing open source <u>Examiner's Comments</u> Candidates who understood that the source code is not available did well on this question as they were then able to expand their answer and gain full marks. Some candidates described open source without giving a drawback of closed source.
			Total	**8**	

Question			Answer/Indicative content	Marks	Guidance
8			1 mark each to max 4 e.g. • Code can easily be reused… • …classes can be used in other programs • …inheritance can be to extend upon existing classes • …as a class can be based on an existing class • Easier to maintain…. • ….as classes can be modified or extended • …debugging can be easier as encapsulation limits how attibutes are changed. • Code can be more secure… • … as access to attributes can be restricted to being via methods. • Better for coding as part of a team… • …as classes can be distributed between team members.	4	1 mark per benefit identified and 1 mark per expansion. Max 2 benefits and 1 expansion per benefit. <u>Examiner's Comments</u> Many candidates were more successful on this part of Section B as it was an AO1 book learnt topic rather than the preceding AO2 OOP programming application elements. However, benefits were often poorly described, or OOP components were just named without a relevant expansion as to how they could be used.
			Total	4	

Question			Answer/Indicative content	Marks	Guidance
9		i	• 8, 7 • 15 • 15,6	3	One mark per stack diagram Examiner's Comments This question was generally well answered although some candidates struggled to understand the concept of a stack and how data is pushed on to it and popped from it.
		ii	• 12 • 7 • 15	3	Examiner's Comments This was generally well answered, with the biggest misunderstanding being the way the subtraction occurs.
		iii	• S causes the two values inputted to be popped and only one value to be pushed back // 4 and 2 are popped and 2 is pushed • A causes an attempt to pop **two values but only one present / not two values there** • Causing a **stack** underflow	3	Examiner's Comments Many candidates were able to gain at least one mark on this question for stating that the addition would only be able to pop one number. The candidates who gained full marks were able to state the type of error correctly and explain why there was only one value able to be popped after the subtraction.
			Total	9	
10			• A piece of software which allows **hardware/device to communicate**… • …with the **operating system**	AO1.2 (2)	Examiner's Comments 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	

Question			Answer/Indicative content	Marks	Guidance
11		i	1 mark per bullet to max • Queue has head pointer and tail pointer • When an item is enqueued the tail pointer increments • When an item is dequeued the head pointer increments	3	Max 1 mark for Enqueue/Dequeue operations if description of effect on tail/head pointers not given <u>Examiner's Comments</u> Many candidates identified the need to have a head/tail pointer but struggled to gain more than 1 mark by expanding on how enqueue and dequeue operations would be implemented. Some candidates continued to talk about push/pop operations for a queue rather than enqueue/dequeue and often gave properties of a queue in general such as First In First Out rather than answering the question.

Question			Answer/Indicative content	Marks	Guidance
		ii	**Mark Band 3 – High level** **(7-9 marks)** The candidate demonstrates a thorough knowledge and understanding of object-oriented and procedural programming; 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. *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 object-oriented and procedural programming; 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 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*. **Mark Band 1 – Low Level** **(1-3 marks)**	9 AO1.1 (2) AO1.2 (2) AO2.1 (2) AO3.3 (3)	**AO1: Knowledge and Understanding** **Indicative content** • OOP defines an object as an independent entity • OOP defines the attributes of the object and the methods that can be applied to it • attributes could be private to restrict accidental changes • Procedural the statements are executed in the order they are written **AO2: Application** • OOP allows for an object to be created from the queue • Many instances of this queue can then be declared in the main program. • Procedural will need each queue to be declared individually • Procedural will need to make use of subroutines where the queue will need to be sent and returned each time. **AO3: Evaluation** • OOP you can create multiple instances of the queue as required by the program without having to re-write all of the declarations etc. In procedural you would have to write separate code for each new stack • OOP reduces amount of code needed therefore fewer errors are likely as code is written once and then used multiple times • OOP can reduce mistakes because the subroutines are self-contained in procedural it would need to make sure the correct values are passed

Question			Answer/Indicative content	Marks	Guidance
			The candidate demonstrates a basic knowledge of object-oriented and procedural programming with limited understanding shown; the material is basic and contains some inaccuracies. The candidates 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. Judgements if made are weak and unsubstantiated. *The information is basic and comunicated 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.		and returned, or global variables may be required which uses excess memory. <u>Examiner's Comments</u> Many candidates were able to identify some elements of OOP and Procedural programming to achieve a Level 1 response or were able to describe features in detail for a Level 2 response. Far fewer were able to apply this to the specific context to achieve a Level 3 response. Those with good knowledge of OOP stood out in terms of giving clear evaluations of multiple queues generated from instance of the class, encapsulation to reduce side effects and possibilities for inheritance for different types of queues. Many did not describe the necessary creation of enqueue and dequeue subroutines in procedural programming for each separate queue or the need to pass queues to or returning queues from subroutines.  **Misconception** There was a lot of confusion between inheritance and instantiation, e.g. "when creating several queues you can use inheritance, so all queues inherit attributes and methods". Candidates need to be clear that each instance of a class is assigned the attributes of the class and has access to all associated methods.

Question			Answer/Indicative content	Marks	Guidance
			Total	12	

Question			Answer/Indicative content	Marks	Guidance
12			**Mark Band 3–High Level (7-9 marks)** The candidate demonstrates a thorough knowledge and understanding of both waterfall and the spiral model. 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 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. **Mark Band 2-Mid Level (4-6 marks)** The candidate demonstrates reasonable knowledge and understanding of waterfall and/or the spiral model; 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 provides a sound discussion, the majority of which is focused. Evaluative comments are for the most part appropriate, although one or two opportunities for development are missed.	9 (AO1.1), (2) (AO1.2), (2), (AO2.1) (2), (AO3.3). (3)	AO1 The spiral model has four quadrants (determine objectives, identify and manage risk, develop and test, plan next iteration). Client feedback then informs future development and prototypes which feedback into future revisions. Waterfall has a structured analysis/design/development/test flow. Progress to the next step is not made until the previous step is completed. AO2 The spiral model relies on frequent client feedback. Spiral produces functional prototypes where features are added incrementally. Spiral model has more focus on risk; projects may be modified or even dropped if risk is too great. Waterfall is much more structured and very reliant on getting the definition of requirements correct at the start; changes are harder to add in at a later stage. However, this forces the definition to be well understood. AO3 Spiral involves client feedback, prototypes and evolving projects. Better option where requirements may change. Waterfall is better where requirements are very clear to begin with and outcomes known. Spiral is better for risk management. If the programmer has a large team then waterfall may be more appropriate due to the clearly defined responsibilities at each stage. <u>Examiner's Comments</u> Most candidates gained some marks on this question. Most could explain that spiral was iterative and waterfall was done in linear stages, but many did not expand on this. Few candidates

Question			Answer/Indicative content	Marks	Guidance
			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 some aspects of either waterfall or the spiral model; 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 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. **0 marks** No attempt to answer the question or response is not worthy of credit.		linked their answer to the complex computer program mentioned in the question. Some candidates also described waterfall as iterative.
			Total	9	

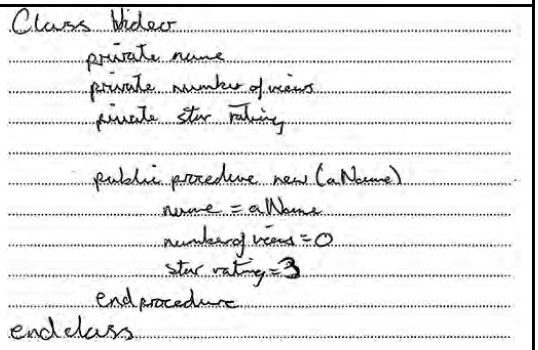
Question			Answer/Indicative content	Marks	Guidance
13		i	• For printer queue • All documents/users have equal priority • Whichever document is received first is printed first • First in First Out / Last in Last Out	2	Examiner's Comments This question was generally well answered with many candidates 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 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.
			Total	7	

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>14</td><td>a</td><td></td><td>
<table>
<tr><th></th><th>Lexical analysis</th><th>Syntax analysis</th><th>Code generation</th></tr>
<tr><td>Comments and white-space are removed</td><td>x</td><td></td><td></td></tr>
<tr><td>Keywords are replaced with tokens</td><td>x</td><td></td><td></td></tr>
<tr><td>Object code is created</td><td></td><td></td><td>x</td></tr>
<tr><td>Symbol table created for variables</td><td>x</td><td></td><td></td></tr>
<tr><td>Builds an abstract syntax tree</td><td></td><td>x</td><td></td></tr>
</table>
</td><td>5</td><td>One mark per row. No mark if more than one/no box is ticked.

Accept other marks that clearly indicate choice (e.g. X)</td></tr>
<tr><td></td><td>b</td><td></td><td>• To make the program run faster// code is more efficient
• To make the program use fewer resources/less memory</td><td>2</td><td><u>Examiner's Comments</u>
Many candidates gave good descriptions of how code is optimised, but they did not answer the question which asked what the purpose of optimisation is.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>7</td><td></td></tr>
</table>

Question			Answer/Indicative content	Marks	Guidance

15		i	• Class definition with identifier video
			• name, number of views and star rating attributes defined…
			• …As private
			• Constructor method definition inside class definition…
			• …that accepts only one parameter
			• …Name attribute set to parameter passed in
			• Views set to 0 and rating set to 3 **either** when initialised or in constructor.
				7	Accept implementations in high-level languages (e.g. __ for private, class name used for constructor, no need for end of class definition in Python)
					
					BP1 - allow empty brackets. Do not allow anything in the brackets
					BP5 - ignore self if included as parameter
					
					`class video`
					`  private name`
					`  private views`
					`  private starrating`
					
					`  public procedure new(newname)`
					`  name = NewName`
					`  views = 0`
					`  starrating = 3`
					`  end procedure`
					`end class`
					
					Examiner's Comments
					This question was well answered by some candidates. The question asks for pseudocode or program code and candidates should be encouraged to do one or the other if given a choice, rather than a combination of the two. Many candidates did not use the information in the question stem to help them structure their answer and gave more than one parameter in the constructor.
					
					Exemplar 3

Question			Answer/Indicative content	Marks	Guidance
					 Class Video private name private number of views private star rating public procedure new(aName) name = aName number of views = 0 star rating = 3 end procedure end class This was a good clear example of an answer given in pseudocode. The candidate has declared the 3 given attributes as private, shown a constructor with one parameter and set name to the parameter and views and rating to 0 and 3. The candidate gained 7 marks.

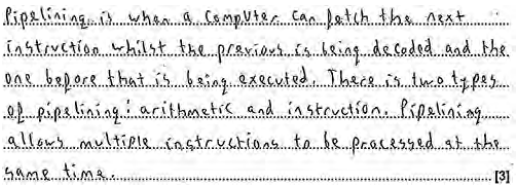
		ii	• Method definition <u>that is public</u>
			• View attribute incremented by one
				2	`public procedure updateviews()`
					`    views = views + 1`
					`end procedure`
					
					View attribute must have the same name as part i
					
					<u>Examiner's Comments</u>
					Most candidates were able to gain at least 1 mark for this question. Those who were not given marks used pseudocode but did not state that the procedure was public, or they did not use the same attribute they had declared in Question 2 (g) (i).

			Total	**9**	
16		i	• 40	1	CAO
		ii	• 70	1	CAO
		iii	• 300	1	CAO
			Total	**3**	

Question			Answer/Indicative content	Marks	Guidance
17		i	• 10 • 60 • 200	3	1 mark per number <u>Examiner's Comments</u> This was generally well answered by candidates who had a good understanding of LMC. Candidates should be encouraged to trace through LMC programs with different values as well as writing them.

Question			Answer/Indicative content	Marks	Guidance

		ii	• Loads a value into the accumulator
			• Establishes a zero value (by use of DAT / SUB)
			• Stores a zero value into total
			• Program stops
				4	Example 1
					`LDA zero`
					`STA total`
					`HLT`
					`zero DAT 0`
					
					Example 2
					`LDA total`
					`SUB total`
					`STA total`
					`HLT`
					
					BP1 can be given for any value being loaded into the accumulator e.g. INP
					
					If candidate writes LDA donation/total (case sensitive) they can get BP2 as they've used the labels from the question
					
					BP3 - total is case sensitive as given in the question
					
					BP4 - must not be given if the zero value will be attempted to be fetched e.g. HLT is placed after DAT
					
					Examiner's Comments
					This was generally answered well, and the majority of students were able to gain marks with most gaining 3 or 4 marks. Less successful responses over complicated the program leading to them making mistakes. A small number of candidates attempted to answer in pseudocode rather than LMC. Candidates should be encouraged to use the commands in Appendix 5d of the specification.

Question			Answer/Indicative content	Marks	Guidance
		iii	• One **instruction** can be fetched while another is being decoded… • …and another is executed • The output of one process/instruction is the input of the next. • Concurrent processing of multiple instructions // completing multiple FDE cycles at once	3	For BP1, allow any 2 of the 3 parts of the FDE cycle For BP2, must give the other part of the FDE cycle not given in BP1 Do not award if explaining multiple cores working on different parts of FDE cycle Examiner's Comments Many candidates were able to gain at least 2 marks on this question. Some candidates were not awarded marks as they wrote about multiple cores or programs being fetched instead, of instructions. Exemplar 1  Pipelining is when a computer can fetch the next instruction whilst the previous is being decoded and the one before that is being executed. There is two types of pipelining; arithmetic and instruction. Pipelining allows multiple instructions to be processed at the same time. [3] The candidate has clearly described pipelining with correct terminology. They gained full marks for the description of one instruction being decoded while another is fetched and another is executed, as well as describing that it allows multiple instructions to be processed at the same time.

Question			Answer/Indicative content	Marks	Guidance
		iv	• More instructions can be carried out in a **set amount of time** // **less time** to execute the same number of instructions • Increasing the speed/performance/efficiency of the computer/program // quicker for the program to complete	2	Do not allow “each instruction is quicker to execute”. BP2 has to be specific to the charity e.g. processing more donations Examiner’s Comments Many candidates gained 1 mark for giving a benefit to the charity, but they did not go on to say why pipelining enabled that. Some candidates did not apply their answer to the charity, so were not awarded the mark for the benefit.
			Total	**12**	
18			1 mark per bullet up to a maximum of 2 marks, e.g.: • Blackbox testing • Whitebox testing • Alpha testing • Beta testing	2 (AO1.1) (2)	Examiner’s Comments Most candidates responded well with good factual recall of testing strategies. Some candidates did confuse testing strategies with types of test data that could be used within a test strategy or described validation checks that could be performed on input values.
			Total	**2**	

Question			Answer/Indicative content	Marks	Guidance
19			1 mark per bullet up to a maximum of 2 marks, e.g: • Disk Defragmentation… • …To keep optimal r/w speed for her HDD • File management… • …To allow easy access to her file system • Disk Drivers… • … To allow her to use new peripheral devices • System Clean-up… • … to keep her system free of redundant files • Anti-Virus/Malware… • … to find and remove/quarantine viruses/malware (A worms/trojans etc)	4 (AO1.1) (2) (AO1.2) (2)	1 Mark for a suitable utility and 1 mark for a relevant example for that utility. Do not accept task manager Accept: • Compression Software … • … to make the file size smaller • Backup Software … • … to make copies of files <u>Examiner's Comments</u> This question was generally answered well although many candidates achieved 2 rather than 4 marks. Commonly, two utilities were correctly identified but the explanation to accompany the utility was too vague. Candidates were required to give examples of how the utilities could be used with the given scenario.
			Total	**4**	
20			To create an instance of an object from a class	1 AO2.1 (1)	
			Total	**1**	