COMPONENT 1 Fundamentals of Computer Science

MARK SCHEME

Guidance for examiners

Positive marking

It should be remembered that learners are writing under examination conditions and credit should be given for what the learner writes, rather than adopting the approach of penalising him/her for any omissions. It should be possible for a very good response to achieve full marks and a very poor one to achieve zero marks. Marks should not be deducted for a less than perfect answer if it satisfies the criteria of the mark scheme.

For questions that are objective or points-based the mark scheme should be applied precisely. Marks should be awarded as indicated and no further subdivision made.

For band marked questions in **Component 1,** mark schemes are in two parts.

Part 1 is advice on the indicative content that suggests the range of computer science concepts, theory, issues and arguments which may be included in the learner's answers. These can be used to assess the quality of the learner's response.

Part 2 is an assessment grid advising bands and associated marks that should be given to responses which demonstrate the qualities needed in AO1, AO2 and AO3. Where a response is not creditworthy or not attempted it is indicated on the grid as mark band zero.

Banded mark schemes

Banded mark schemes are divided so that each band has a relevant descriptor. The descriptor for the band provides a description of the performance level for that band. Each band contains marks.

Examiners should first read and annotate a learner's answer to pick out the evidence that is being assessed in that question. Once the annotation is complete, the mark scheme can be applied.

This is done as a two stage process.

Stage 1 – Deciding on the band
When deciding on a band, the answer should be viewed holistically. Beginning at the lowest band, examiners should look at the learner's answer and check whether it matches the descriptor for that band. Examiners should look at the descriptor for that band and see if it matches the qualities shown in the learner's answer. If the descriptor at the lowest band is satisfied, examiners should move up to the next band and repeat this process for each band until the descriptor matches the answer.

If an answer covers different aspects of different bands within the mark scheme, a 'best fit' approach should be adopted to decide on the band and then the learner's response should be used to decide on the mark within the band. For instance if a response is mainly in band 2 but with a limited amount of band 3 content, the answer would be placed in band 2, but the mark awarded would be close to the top of band 2 as a result of the band 3 content. Examiners should not seek to mark candidates down as a result of small omissions in minor areas of an answer.

Stage 2 – Deciding on the mark
Once the band has been decided, examiners can then assign a mark. During standardising (marking conference), detailed advice from the Principal Examiner on the qualities of each mark band will be given. Examiners will then receive examples of answers in each mark band that have been awarded a mark by the Principal Examiner. Examiners should mark the examples and compare their marks with those of the Principal Examiner.

When marking, examiners can use these examples to decide whether a learner's response is of a superior, inferior or comparable standard to the example. Examiners are reminded of the need to revisit the answer as they apply the mark scheme in order to confirm that the band and the mark allocated is appropriate to the response provided.

Indicative content is also provided for banded mark schemes. Indicative content is not exhaustive, and any other valid points must be credited. In order to reach the highest bands of the mark scheme a learner need not cover all of the points mentioned in the indicative content but must meet the requirements of the highest mark band. Where a response is not creditworthy, that is contains nothing of any significance to the mark scheme, or where no response has been provided, no marks should be awarded.

<table>
<tr><th>Q</th><th>Answer</th><th>Mark</th><th>AO1</th><th>AO2</th><th>AO3</th><th>Tot</th></tr>
<tr><td>1a</td><td><u>Component A</u>
• Name: Control unit
• Explanation: Fetches each instruction in sequence, decodes and synchronises it before executing it by sending control signals to other parts of the computer.

<u>Component B</u>
• Name: Arithmetic Logic Unit (Accept ALU)
• Explanation: The processing and manipulation of data which normally consists of arithmetic operations or logical comparisons, allowing a program to take decisions</td><td>1
1

1
1</td><td>1.1a
1.1b

1.1a
1.1b</td><td></td><td></td><td>4</td></tr>
<tr><td>1b</td><td>Logical operator: AND

Truth table
<table><tr><th>Input (A)</th><th>Input (B)</th><th>Output (A AND B)</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>
Table could also be written as:
<table><tr><td></td><td>0</td><td>1</td></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td></tr></table>
Original 1001 0110 1101 1011
Mask 0000 0000 0000 0000
Result 0000 0000 0000 0000</td><td>1

1

1</td><td>

1.1a</td><td>2.1a

2.1a</td><td></td><td>3</td></tr>
<tr><td>2a</td><td>Description should include the following:

A protocol is a standard set of rules that enable devices to communicate with each other.

Network protocols are important as programs where a programmer invents their own protocol would be unable to communicate with other programs.</td><td>

1

1</td><td>

1.1b

1.1b</td><td></td><td></td><td>2</td></tr>
<tr><td>2bi</td><td>IMAP – transferring emails (NOT messages) between computer systems (via the internet).</td><td>1</td><td>1.1a</td><td></td><td></td><td>1</td></tr>
<tr><td>2bii</td><td>DHCP – assigning dynamic IP addresses to devices on a network.</td><td>1</td><td>1.1a</td><td></td><td></td><td>1</td></tr>
<tr><td>2biii</td><td>UDP – sending datagrams across a network with very few error recovery services.</td><td>1</td><td>1.1a</td><td></td><td></td><td>1</td></tr>
<tr><td>3a</td><td>Data is split and stored on different parts of the disc.

If data is fragmented, it takes longer for the disc heads to move between parts of the file, which slows the process of loading it.</td><td>1

1</td><td>1.1a

1.1b</td><td></td><td></td><td>2</td></tr>
</table>

Q	Answer	Mark	AO1	AO2	AO3	Tot
3b	• SSD uses direct access to data (files) so there would be no improvement in read times as there's no physical read-head to move • Defragmentation may perform "trim" command which may slightly improve the speed of future write operations • SSD is currently made out NAND based flash memory, NAND based flash memory has a limited lifespan – defragmentation process may shorten its lifespan.	1 1 1	1.1b 1.1b 1.1b			3
4ai	Simplex. Transmission of data is in one direction only Which would allow sound to be sent by the computer to the speakers with no feedback required	1 1 1		2.1a 2.1a 2.1a		3
4aii	Full-duplex. Simultaneous transmission of data in both directions is possible Which would allow both video and sound to be transmitted to all members of the conference at the same time.	1 1 1		2.1a 2.1a 2.1a		3
4b	• Multiplexing is where several independent data sources are **combined** • to be sent along a **single route** to a specific destination • Switching is the process of examining packets and routing data to a specific destination.	1 1 1	1.1b 1.1b 1.1b			3
4c	Any **three** of: • Source address o allows tracing of sender • Destination address o allows packet to be routed to destination • Re-assembly information / packet number o allows packets to be assembled in correct order • Tracking information o allows route taken to be traced • The data itself o required as packet can contain meaningful data • Checksum o allows checking of data for errors 1 mark for identifying item 1 mark for description of purpose	3 3	1.1a 1.1b			6
5a	00100101 00111100 + **01100001** Hexadecimal number = 61	 1 1		 2.1a 2.1a		2
5b	10001101	1		2.1a		1

Q	Answer	Mark	AO1	AO2	AO3	Tot
5c	One method is: • From RHS, rewrite it up to and including the first one • Change other 1 digits to 0 and 0 digits to 1 Correct working and answer for example • 00001000 → xxxx1000 → 11111000 Alternatively: • Flip the bits • Add one (Ignore carry (ninth bit)) Other methods equally acceptable	 1 1	 1.1b	 2.1a		2
5di	Advantage: • greater range of (positive/negative) numbers can be stored in the same number of bits Disadvantage (any one of): • are not normally stored completely accurately • require more complex processing • no exact representation of zero	 1 1	 1.1b 1.1b			2
5dii	0.11111101000 0110 1 for correct mantissa, 1 for correct exponent	2		2.1a		2
5diii	• Mantissa = 0.6875 or 11/16, Exponent = 5 • Answer = Mantissa x $2^{exponent}$ • Answer = 22	1 1 1		2.1a 2.1a 2.1a		3
6	Expression — Rule(s) Used (A + C).(A.D + A.$\overline{D}$) + A.C + C — Original Expression (A + C).A.(D + $\overline{D}$) + A.C + C — Distributive. (A + C).A + A.C + C — Complement, Identity. A.((A + C) + C) + C — Commutative, Distributive. A.(A + C) + C — Associative, Idempotent. A.A + A.C + C — Distributive. A + (A + 1).C — Idempotent, Identity, Distributive. A + C — Identity, twice. Can also use distribution of or over and starting from A(A+C)+C to reach the same result by another route.	 1 1 1 1 1 1 1		 2.1a 2.1a 2.1a 2.1a 2.1a 2.1a 2.1a		7

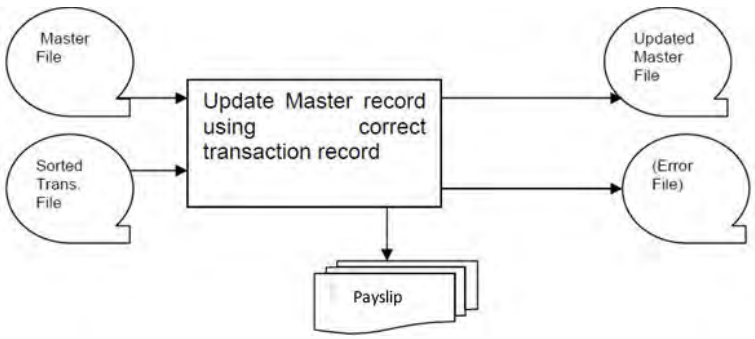
Q	Answer	Mark	AO1	AO2	AO3	Tot
7	**High level (any three of):** • They are easier to understand, learn and program as commands are more English-like • Identifiers can be long and meaningful • They allow the use of powerful commands that perform quite complex tasks • Allows creation of modules that can be re-used and accessed by other parts of the program	3	1.1b			6
	Low level (any three of): • Ideal when the execution speed is critical, e.g. boot strap loader • More efficient than high level language programs • Require less time for translation into machine code • Generally result in smaller executable programs (more machine code than necessary)	3	1.1b			

8	declare Reading array(1..999) of integer
	set Total = 0
	set Max = 0 (or any integer < 0)
	set NumHighs = 0
	input NumReadings
	for Count = 1 to NumReadings
	   input Reading(Count)
	   set Total = Total + Reading(Count)
	   if Reading(Count) > Max then set Max = Reading(Count)
	endfor
	set Mean = Total / NumReadings
	for Count = 1 to NumReadings
	   if Reading(Count) > Mean then set NumHighs = NumHighs+1
	endfor
	output "Mean Reading = ", Mean
	output "Number of readings above mean = ", NumHighs
	output "Highest reading = ", Max
						7

	Award one mark for each:					
	• Initialise and first input	1			3.1b	
	• First loop structure	1			3.1b	
	• Input and two updates	1			3.1b	
	• Second Loop structure	1			3.1b	
	• Update	1			3.1b	
	• Calculate mean	1			3.1b	
	• Three outputs	1			3.1b	
	Other approaches are possible and will be given full credit if correct. No marks are given for brevity/efficiency/elegance.					

Q	Answer	Mark	AO1	AO2	AO3	Tot
9	An IDE provides programmers with various **tools** that are needed to **create** computer programs. Any **three** of the below features: • **Editor:** this allows a programmer to enter, format and edit source code to produce a program. • **Compiler:** this converts source code into executable machine code to allow a program to be run. Once compiled, a program can be run at any time. • **Interpreter:** this converts each line of source code into machine code, and executes it as each line of code is run. The conversion process is required for a program to run and is performed each time the program needs to be run. • **Linker:** this is a program which allows previously compiled code, from software libraries, to be linked together to produce a single executable program. • **Loader:** this is a program which loads previously compiled code into memory allowing a program to execute. • **Debugger:** this is a program that assists in error checking by helping locate, identify and rectify errors in a program. • **Trace:** this is a facility that assists in error checking by displaying the order in which the lines of a program are executed, and possibly the values of variables as the program is being run. • **Break point:** this is a facility that assists in error checking by interrupting a program on a specific line of code, allowing the programmer to compare the values of variables against expected values. The program code can then usually be executed one line at a time. This is called *single-stepping*. • **Variable watch:** this is a facility that assists in error checking by displaying the current value of any variable. The value can be 'watched' as the program code is single-stepped to see the effects of the code on the variable. Alternatively a variable watch may be set, which will interrupt the program flow if the watched variable reaches a specified value. • **Memory inspector:** this is a facility which will display the contents of a section of memory and allows content to be checked for errors. • **Error diagnostics:** these are used when a program fails to compile or to run. Error messages are displayed to help the programmer more easily diagnose what has gone wrong.	1 3	1.1a 1.1b			4
10a	A pass is made through the data, comparing each value with the following one and swapping them if necessary. A number of passes are made until the data is in order.	1 1	1.1b 1.1b			2

Q	Answer	Mark	AO1	AO2	AO3	Tot
10b	Any **two** of: **45 32 5 32 19 62 (duplicated number)** **5 19 32 35 45 62 (ascending order) or** **62 45 35 32 19 5 (descending order)** **32 45 19 62 -35 5 (negative number)** ***Accept* (but cannot gain two marks for repetition of these (e.g. if two arrays showing two different sets of more than 6 integers)):** Example with: • <6 or >6 integers • Decimal(s) • Letters / other characters	1 1		2.1b 2.1b		2
11	Summary should draw on any **eight** of the following points: • Communicates with and sends data output to a printer / monitor / other valid output device • Communicates with and receives data input to a keyboard / mouse / other valid input device • In spooling, data is stored on hard disc / in memory / stored in a queue / in a buffer • Manages backing store by ensuring that data is stored and can be retrieved correctly from any disc drive • O/S creates and maintains a filing system such as FAT or NTFS • Organise files in a hierarchical directory structure • O/S offers compression which can be used to save disc space • The O/S manages memory (RAM) by ensuring all programs and data including itself is stored in correct memory locations/do not try to occupy the same memory location • The O/S manages memory (RAM) by ensuring all programs and data have enough memory allocated • The O/S can utilise virtual memory when not enough memory (RAM) is available to run a program • Ensures different processes can utilise the CPU and do not interfere with each other or crash • On a multi-tasking O/S, the O/S ensures that all tasks appear to run simultaneously	8	1.1b			8

Q	Answer	Mark	AO1	AO2	AO3	Tot
12a	Sequential file is most suitable because employee records need to be accessed in order for update process. Serial file most suitable because hours worked are entered in no particular order.	1 1		2.1a 2.1a		2
12b	Employee ID / Number	1		2.1a		1
12c	• Two input files: old master file and **sorted** transaction file • Explanation of update process i.e. **comparison** record by record with **corresponding** master record - update master record where appropriate • New (updated) master file and pay slip as output – arrows must clearly show flow of record • After last transaction record is processed, remaining old master records are read from old master file and written to new master file  	1 1 1 1		2.1b 2.1b 2.1b 2.1b		4

Q	Answer	Mark	AO1	AO2	AO3	Tot
13	Comparison can refer to commonalities and differences between changeover methods as referenced in the indicative content. **Indicative content** Direct “big bang” approach can be adopted - sudden change to new system o Could be used where a failure would not be catastrophic o Can be cheaper to implement o New system is available immediately if required o Can be the least disruptive if implemented well o New system may not work as well until staff are fully used to using it o If new system fails organisation have no system which could be costly or dangerous Parallel running - both systems running together for a time o Safest option as if new system fails they still have existing system o New system is available immediately if required o The outputs from the old and new systems can be compared to check that the new system is running correctly o Expensive as require temporary staff or overtime for current staff to operate both systems o Could cause confusion for staff / customers having two systems Phased changeover - part-by-part (by functionality) o Allows users to gradually get used to the new system o Staff training can be done in stages o All staff can focus on one area to resolve any problems o Problems can be fixed quicker as more experts to resolve one functionality problem at a time o Difficulties identified in one area can be resolved and managed in next area	10	1.1b			13

	○ Might cause problems in the changeover period when they need to communicate with each other and have different systems ○ Slower to get new system up and running compared to some other methods ○ If a part of the new system fails, there is no back-up system, so data can be lost Pilot changeover - part-by-part (by part of the organisation) ○ All features of the new system can be fully trialled ○ If something goes wrong with the new system, only a small part of the organisation is affected ○ The staff who were part of the pilot scheme can help train other staff. ○ All staff can focus on one area to resolve any problems ○ Difficulties identified in one area can be resolved and managed in next area ○ For the office / department doing the pilot, there is no back-up system if things go wrong ○ Might cause problems in the changeover period when they need to communicate with each other and have different systems ○ Slower to get new system up and running compared to some other methods Consideration of processes that would protect the security and integrity of data during changeover: • Disaster recovery policies in place ○ backups should be in place for both old and new system ○ archiving off-site ○ backup system – compatible with old and new system ○ staff need to be trained to be able to recover data from systems successfully • Do archived files need to be restored to new system • Data redundancy occurs in computer systems where the same data is stored in two or more places which leads to inconsistency. ○ this could be a problem when the same data is stored on two different systems • Standard backup procedures ○ e.g. three generations of backup • Review levels of permitted access ○ allow users to read / write to / amend / delete only parts of the system ○ allow users to access only certain data	3		2.1a		

Band	AO1.1b Max 10 marks	AO2.1a Max 3 marks
3	**8-10 marks** The candidate has: • written an extended response that has a sustained line of reasoning which is coherent, relevant, and logically structured • shown clear understanding of the requirements of the question and a clear knowledge of the indicative content. Clear knowledge is defined as a response that provides four to five relevant detailed points on each of two changeover methods, which relate to an extensive amount of the indicative content • addressed the question appropriately with minimal repetition and no irrelevant material • has presented a balanced discussion and justified their answer with examples • effectively drawn together different areas of knowledge, skills and understanding from all relevant areas across the course of study. Effectively drawn together is defined by a response that identifies two methods of changeover and relates these to specific security considerations relevant to those changeover methods • used appropriate technical terminology referring to the indicative content confidently and accurately.	**3 marks** The candidate has: • shown clear understanding of the requirements of the question and a clear knowledge the processes that would protect the security and integrity of data during changeover. Clear knowledge is defined as a response that provides three relevant detailed points on the practical implications of managing security and data during the changeover process, which relate to the indicative content.
2	**4-7 marks** The candidate has: • written a response that has an adequate line of reasoning with elements of coherence, relevance, and logical structure • shown adequate understanding of the requirements of the question and a satisfactory knowledge of the topic of changeover as specified in the indicative content. Satisfactory knowledge is defined as a response that provides four to seven points across two changeover methods as signalled in the indicative content. Up to five marks could be awarded to a response that provides detailed points on one changeover method • has presented a discussion with limited examples • drawn together different areas of knowledge, skills and understanding from a number of areas across the course of study. Drawn together is defined by a response that identifies two methods of changeover and identifies security considerations, although these may not be relevant to the changeover methods described • used appropriate technical terminology referring to the indicative content.	**2 marks** The candidate has: • shown adequate understanding of the requirements of the question and a satisfactory knowledge of the topics of security and integrity of data as specified in the indicative content. Satisfactory knowledge is defined as a response that provides two relevant points on the practical implications of managing security and data during the changeover process, which relate to the indicative content.

Band	AO1.1b Max 10 marks	AO2.1a Max 3 marks
1	**1-3 marks** The candidate has: • written a response that that lacks sufficient reasoning and structure • produced a discussion which is not well developed • attempted to address the question but has demonstrated superficial knowledge of the topics specified in the indicative content. Superficial knowledge is defined as a response that provides one to three points on only one changeover method as signalled in the indicative content • used limited technical terminology referring to the indicative content.	**1 mark** The candidate has: • attempted to address the question but has demonstrated superficial knowledge of the topics specified in the indicative content. Superficial knowledge is defined as a response that provides one relevant point on the practical implications of managing security and data during the changeover process, which relate to the indicative content.
0	**0 marks** Response not credit worthy or not attempted.	**0 marks** Response not credit worthy or not attempted.