Cambridge Assessment International Education

Cambridge International AS & A Level

COMPUTER SCIENCE **9618/31**

Paper 3 Problem Solving & Programming **October/November 2022**

MARK SCHEME

Maximum Mark: 75

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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Question	Answer	Marks
1(a)	**Two** marks for working **One** mark for correct answer Working: Conversion to binary + 202 = 11001010 // repeated division by 2 // 128 + 64 + 8 + 2 Appropriate shifting of binary point for + 202 = 0.1100101×2^8 // exponent = 8 Answer: = 01100101 00001000 (stored as mantissa and exponent)	**3**
1(b)	**Two** marks for working **One** mark for correct answer Working: • Appropriate method of conversion e.g. = 10011010 (one's complement of 8-bit mantissa) = 10011011 (two's complement of 8-bit mantissa) –256 + 32 + 16 + 4 +2 • Realisation that the exponent doesn't change // value of exponent = 8 // appropriate shifting of binary point Answer: = 10011011 00001000 (stored as mantissa and exponent)	**3**
1(c)(i)	The mantissa does not begin with 01/10 (as its most significant bits) // the mantissa begins with 00 // first two digits are the same.	**1**
1(c)(ii)	**One** mark for each point: • Correct mantissa • Correct exponent **Mantissa** 0 1 1 1 1 0 0 0 **Exponent** 0 0 0 1 0 1 1 0	**2**

Question	Answer	Marks
2	**One** mark for each point (**Max 3**) MP1 The Transport Layer breaks data into manageable packets / performs segmentation MP2 It sequences the packets // adds data to the packet header // adds a **packet header** MP3 It sends the packets to the Internet / Network Layer // It receives data from the Application Layer MP4 It controls the flow of packets MP5 It handles packet loss/corruption // Acknowledges receipt of complete error free packets **One** mark for each point (**Max 3**) MP6 The Internet Layer identifies the intended network and host MP7 It transmits packets to the (Data) Link / Physical Layer MP8 It routes the packets independently through the **optimum** route MP9 It addresses packets with their source and destination IP addresses MP10 It then uses an IP address and port number to form a socket.	**5**

Question	Answer	Marks
3(a)	A (user-defined non-composite) data type with an **ordered list** of possible values.	**1**
3(b)	A user-defined non-composite data type used to reference a **memory location**.	**1**
3(c)	Marks as shown in the square brackets: TYPE Quarter1 = (January, February, March) `TYPE Quarter1 =` [1] `(January, February, March)` [1]	**2**
3(d)(i)	`DECLARE Pet1 : Pet`	**1**

Question	Answer	Marks

3(d)(ii)	**One** mark for each point:
	
	• Correct assignment of **all** string data values
	• Correct assignment of char data value
	• Correct assignment of integer data value
	
	Example answer:
	
	`Pet1.PetName ← "Tibbles"`
	`Pet1.AnimalType ← "Cat"`
	`Pet1.PetAge ← 8`
	`Pet1.PetGender ← 'M'`
	`Pet1.OwnerName ← "Jasmine Smith"`
		3

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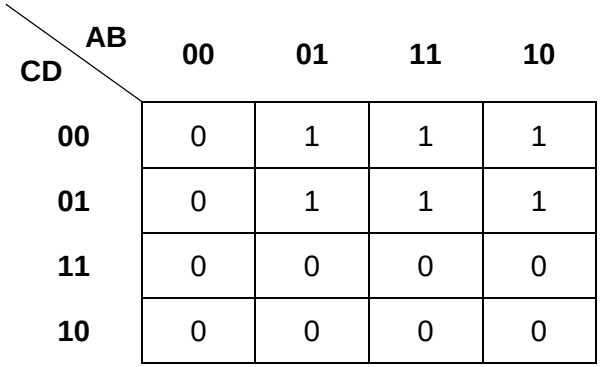
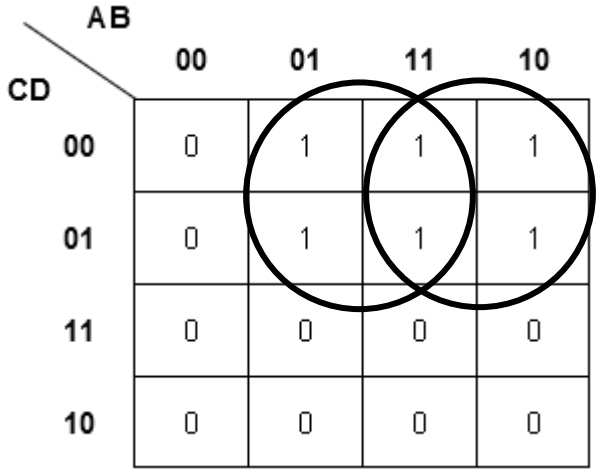
Question	Answer	Marks
4	**One** mark for each correct line connecting one stage of compilation to a description **Stage of compilation** / **Description** Lexical analysis → converting a sequence of characters into a sequence of tokens Syntax analysis → using parsing algorithms to interpret the meaning of a sequence of tokens Code generation → converting an intermediate representation of source code into an executable form Optimisation → minimising a program's execution time and memory requirement directly executing instructions written in a scripting language	**4**

Question	Answer	Marks
5(a)	`a b * b + d - 15 +`	**1**
5(b)(i)	`(a - b) * (c + d) / a`	**1**
5(b)(ii)	`-39`	**1**

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Question	Answer	Marks
6(a)	**One** mark for each correct point (**Max 2**) • A private key is the unpublished/secret key/never transmitted anywhere. • It has a matching public key • It is used to decrypt data that was encrypted with **its** matching public key.	**2**
6(b)	**One** mark for each correct point (**Max 2**) • The message to be sent is encrypted using the **recipient's public** key. // The message to be sent is encrypted using the **sender's private** key. • The message is decrypted using the **recipient's private** key. // The message is decrypted using the **sender's public** key.	**2**
6(c)	**One** mark for each correct point (**Max 4**) • The message together with the digital signature is decrypted using the receiver's private key • The digital signature received is decrypted with the sender's public key to recover the message digest sent • The decrypted message received is hashed with the agreed hashing algorithm to reproduce the message digest of the message received • The two message digests are compared • … if **both digests** are the same the message has **not** been altered // if they are different the message has been altered.	**4**

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Question	Answer	Marks
7(a)	**Two** marks if no errors present **One** mark if one error present 	**2**
7(b)	**One** mark for correct loop **(Max 2)** 	**2**

Question	Answer	Marks
7(c)	**One** mark for each point • Any correct Boolean term • Boolean terms and operator correct and no other terms present (Z =) $B\overline{C} + A\overline{C}$ **One** mark for simplest form (Z =) $\overline{C}$ (A + B)	**3**

Question	Answer	Marks
8(a)	**One** mark for each correct point (**Max 3**) • Disk / secondary storage is used to extend the RAM / memory available • … so the CPU appears to be able to access more memory space than the available RAM • Only the data in use needs to be in main memory so data can be swapped between RAM and virtual memory as necessary • Virtual memory is created temporarily.	**3**
8(b)	**One** mark for a correct statement about the difference between paging and segmentation e.g. • Paging allows the memory to be divided into fixed size blocks and Segmentation divides the memory into variable sized blocks. • The operating system divides the memory into pages, the compiler is responsible for calculating the segment size. • Access times for paging is faster than for segmentation.	**1**

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Question	Answer	Marks
9(a)	**One** mark for each correct point (**Max 2**) • Uses artificial **neural** network(s) • … that contain(s) a high number of **hidden layers** • … modelled on the human brain. • Deep learning uses **many** layers to progressively extract higher level features from the (raw) input. • Deep learning is a **specialised** form of machine learning.	**2**
9(b)	**One** mark for each correct point (**Max 2**) • Deep learning makes good use of unstructured data. • Deep learning outperforms other methods if the data size is large. • Deep learning systems enable machines to process data with a nonlinear approach. • Deep learning is effective at identifying (hidden) patterns / patterns that humans might not be able to see / patterns that are too complex / time consuming for humans to carry out. • It can provide a more accurate outcome with higher numbers of hidden layers.	**2**

Question	Answer	Marks
10(a)	**Two** marks for all five rows correct **One** mark for four rows correct	**2**

Statement	RISC	CISC
uses a smaller instruction set	✓	
uses single-cycle instructions and limited addressing modes	✓	
uses fewer general-purpose registers		✓
uses both hardwired and micro coded control unit		✓
uses a system where cache is split between data and instructions	✓	

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Question	Answer	Marks
10(b)	**One** mark for each correct point (**Max 4**) • Instructions are divided into subtasks / 5 stages • … Instruction fetch / IF, Instruction decode / ID, operand fetch / OF, opcode/instruction execute IE, result store / write back result / WB • Each subtask is completed during one clock cycle • No two instructions can execute their same stage at the same clock cycle • The second instruction begins in the second clock cycle, while the first instruction has moved on to its second subtask. • The third instruction begins in the third clock cycle while the first and second instructions move on to their second and third subtasks, respectively, etc.	**4**

Question	Answer	Marks
11(a)	**One** mark for each correct OOP term definition: • **Instance** – an occurrence of an object // a specific object based on the class // an instantiation of a class. • **Inheritance** – the capability of defining a new class of objects that has all the attributes and methods from a parent class. • **Polymorphism** – allows the same method to take on different behaviours depending on which class is instantiated // methods can be redefined for derived classes.	**3**

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Question	Answer	Marks

11(b)	**One** mark for each point:
	
	• `Car` and `ENDCLASS`
	• Four declarations – must use the identifiers used in the assignments
	• Constructor header – must use `CarBodyType`
	• Two assignments – must use `CarMake`
	• Constructor identifier for the car model and the identifier in the Model assignment statement match
	
	`CLASS` **`Car`**
	`PRIVATE Make : STRING`
	`PRIVATE` **`Model : STRING`**
	`PRIVATE BodyType : STRING`
	`PRIVATE Fuel : STRING`
	`PRIVATE NumberBuilt : INTEGER`
	`PUBLIC PROCEDURE NEW (CarMake : STRING,`
	`CarModel : STRING, CarBodyType : STRING``)`
	`Make ←` **`CarMake`**
	`Model ←` **`CarModel`**
	`BodyType ← CarBodyType`
	`Fuel ← ""`
	`NumberBuilt ← 0`
	`ENDPROCEDURE`
	`getFuel()`
	`getNumberBuilt()`
	`ENDCLASS`
		5

Question	Answer	Marks

12(a)	**One** mark for each point (**Max 6**)
	
	• Initialisation of upper bound
	• Test if upper bound is less than lower bound
	• Re-setting of mid value if current value is lower than the target
	• Re-setting of mid value if current value is higher than the target
	• Finding the value
	• Correct termination of loop
	
	`Lower ← 0`
	`Upper ← 99`
	`Mid ← 0`
	`Exit ← FALSE`
	`OUTPUT "Enter the name to be found "`
	`INPUT Target`
	`REPEAT`
	`  IF Upper < Lower THEN`
	`  OUTPUT Target, " does not exist"`
	`  Exit ← TRUE`
	`  ENDIF`
	`  Mid ← Lower + (Upper - Lower + 1) DIV 2`
	`  IF Names[Mid] < Target THEN`
	`  Lower ← Mid + 1`
	`  ENDIF`
	`  IF Names[Mid] > Target THEN`
	`  Upper ← Mid - 1`
	`  ENDIF`
	`  IF Names[Mid] = Target THEN`
	`  OUTPUT Target, " was found at location ", Mid`
	`  Exit ← TRUE`
	`  ENDIF`
	`UNTIL Exit // UNTIL Exit = TRUE`
		6

12(b)(i)	O(n)	**1**

Question	Answer	Marks
12(b)(ii)	**One** mark for each point (**Max 2**) • O(log n) is a time complexity that uses logarithmic time. • The time taken goes up linearly as the number of items rises exponentially • O(log n) is the worst case scenario (time complexity for a binary search).	**2**

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