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COMPUTER SCIENCE **9618/22**

Paper 2 Fundamental Problem-solving and Programming Skills **October/November 2024**

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 descriptions 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.

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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Mark scheme abbreviations

/	separates alternative words / phrases within a marking point
//	separates alternative answers within a marking point
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be awarded
( )	the word / phrase in brackets is not required, but sets the context

Note: No marks are awarded for using brand names of software packages or hardware.

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Question	Answer	Marks
1(a)	(Corrective) Maintenance	**1**
1(b)	For example: • Set a breakpoint at the start of / within `Lookup,` to stop execution at a given statement • then use single stepping to execute one statement / instruction at a time • to display the value of variables using a watch window One mark for each: **MP1** Order starting with a breakpoint **and** an explanation – 'stop execution at this statement / line' **MP2** Explanation of single stepping – execute 'line by line' / statements **MP3** Explanation of watch window – displaying the value of variable(s)	**3**
1(c)	Features include: **MP1** Editor **MP2** Auto**-** (syntax) complete / auto correction // identify undeclared variables(s) **MP3** Prettyprint / auto-indentation / auto (structure) highlighter **MP4** Dynamic syntax checking **MP5** Expand / collapse code blocks **MP6** Context sensitive prompts **Max 2 marks**	**2**
1(d)	One mark per row: **Variable name** | **Used to store** | **Data type** `Name` | a customer name | **STRING** `Index` | an array index | **INTEGER** `Result` | the result of the division of any two non-zero numbers | **REAL**	**3**

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Question	Answer	Marks

2(a)	Example 'loop solution':
	
	`FUNCTION Conceal(CardNumber : STRING) RETURNS STRING`
	`   DECLARE MaskedString : STRING`
	`   DECLARE Count : INTEGER`
	`   CONSTANT Asterisk = '*'`
	
	`   MaskedString ← RIGHT(CardNumber, 4)`
	`   FOR Count ← 1 TO LENGTH(CardNumber) - 4`
	`       MaskedString ← Asterisk & MaskedString`
	`   NEXT Count`
	
	`   RETURN MaskedString`
	
	`ENDFUNCTION`
	
	Mark as follows:
	MP1 Function heading **and** parameter **and** ending **and** return type
	MP2 Declaration of all local variables used - including the loop counter
	MP3 Calculate number of digits to mask / number of asterisks required
	
	MP4 use of a 'relevant' Loop
	MP5 Correct number of iterations
	MP6 Concatenate asterisk to start/end of `MaskedString` **in a loop**
	
	MP7 Assign last four characters to `MaskedString` // Concatenate the retained original last four digits
	MP8 Return masked string
	
	Max 6 marks
	
	ALTERNATIVE 'non loop' solution:
	
	`FUNCTION Conceal(CardNumber : STRING) RETURNS STRING`
	`   DECLARE MaskedString : STRING`
	`   DECLARE Count : INTEGER`
	`   CONSTANT Asterisks = "********************" //20 asterisks`
	
	`   Count ← LENGTH(CardNumber) - 4`
	`   MaskedString ← LEFT(Asterisks, Count) & RIGHT(CardNumber, 4)`
	
	`   RETURN MaskedString`
	
	`ENDFUNCTION`
	
	Mark as follows:
	MP1 Function heading **and** parameter **and** ending **and** return type
	MP2 Declaration of all local variables used
	MP3 Calculate number of digits to mask / number of asterisks required
		6

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Question	Answer	Marks
2(a)	**MP4** Trim asterisk string to number calculated in **MP3** **MP5** Extract the last four characters **MP6** Concatenate trimmed asterisk string with last four characters of `CardNumber` **MP7** Return masked string **Max 6 marks**	
2(b)(i)	`DECLARE CardNumber : ARRAY [1:100, 1:2] OF STRING` **MP1** Correct dimensions **MP2** All other parts of the statement correct	**2**
2(b)(ii)	Any reference to BYREF // 'by reference'	**1**

Question	Answer	Marks
3(a)(i)	`SP`: 1 `OnStack`: 0 One mark for both correct values	**1**
3(a)(ii)	**MP1** Unused values cannot be popped / taken off the stack // initialised values would never be used / unused elements cannot be accessed **MP2** ... until a value has first been pushed / written // overwrites previous value	**2**

3(b)	Example solution:
	
	`FUNCTION Push(ThisValue : REAL) RETURNS BOOLEAN`
	`   DECLARE ReturnValue : BOOLEAN`
	`   IF` **`OnStack = 60 / >59 // SP = 61 / SP > 60`** `//`
	`      SP` outside the range 1 to 60 `THEN`
	`      RETURN` **`FALSE`** `// Stack is already full`
	`   ENDIF`
	`   `**`ThisStack[SP]`** `← ThisValue`
	`   SP ←` **`SP + 1`**
	`   OnStack ← OnStack + 1`
	`   RETURN TRUE`
	`ENDFUNCTION1`
	
	Mark as follows:
	One mark per gap
		4

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Question	Answer	Marks

4	Example solution:
	
	`PROCEDURE Timer(Mins, Secs : INTEGER)`
	`   DECLARE WarningTick, EndTick : INTEGER`
	
	`   EndTick ← Tick + 1000 * ((Mins * 60) + Secs)`
	`   WarningTick ← EndTick - (30 * 1000)`
	
	`   REPEAT`
	`      //do nothing`
	`   UNTIL Tick = WarningTick`
	`   OUTPUT "30 seconds to go"`
	
	`   REPEAT`
	`      //do nothing`
	`   UNTIL Tick = EndTick`
	
	`   OUTPUT "The time is up!"`
	
	`ENDPROCEDURE`
	
	Mark as follows:
	MP1 Procedure heading **and** parameters **and** ending
	MP2 ‘Attempt’ to calculate ‘total time’/`EndTick` // ‘elapsed time’ // `WarningTick`
	MP3 Correct calculation of `EndTick` **and** `WarningTick`
	
	MP4 **(Design mark)**
	• Two separate loops – checking warning time then the final time, **OR** …
	• Single loop checking the final time with an IF statement to check for warning time, **OR** …
	• Single loop with two IF statements checking the warning time and final time
	
	MP5 Completely correct MP4
	MP6 Output both messages (must be meaningful and follow successful MP4)
		6

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Question	Answer	Marks
5(a)	**MP1** `Count ← INT(100 / Number)` Number could be zero (giving a divide by zero) **MP2** `Index ← Data[Number]` Potential error: Value `Number` could be outside the range of array indices **MP3** `ReturnValue ← TO_UPPER(RIGHT(Label, Count))` Potential Error: Number to extract may be too big / negative / out of range for use in the `RIGHT` function // `Label` has insufficient characters **MP4** `RETURN RetVal` Potential Error: There is no value to be returned // there is no variable named `RetVal` Mark as follows: 1 mark for each statement **and** description **Max 3 marks**	**3**
5(b)	**MP1** Construct: A (pre/post) conditional loop **MP2** Explanation: The terminating condition is never satisfied	**2**

5(c)	Example solution:
	
	`IF Index Mod 2 = 0 THEN`
	`   ReturnValue ← TO_UPPER(RIGHT(Label, Count))`
	`ELSE`
	`   ReturnValue ← "****"`
	`ENDIF`
	
	Mark as follows:
	MP1 `IF...THEN...ELSE...ENDIF`
	MP2 Both correct assignments **and** the correct test/logic
		2

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Question	Answer	Marks

6(a)	Example solution:
	`PROCEDURE Special()`
	`   DECLARE Index : INTEGER`
	`   DECLARE Filling1, Filling2 : STRING`
	
	`   REPEAT`
	`      Index ← INT(RAND(35)) + 1`
	`   UNTIL Filling[Index] <> ""`
	
	`   Filling1 ← Filling[Index]`
	
	`   REPEAT`
	`      Index ← INT(RAND(35)) + 1`
	`   UNTIL Filling[Index] <> "" AND Filling1 <>`
	`                                    Filling[Index]`
	
	`   Filling2 ← Filling[Index]`
	
	`   REPEAT`
	`      Index ← INT(RAND(10) + 1)`
	`   UNTIL Bread[Index] <> ""`
	
	`   OUTPUT "The daily special is ", Filling1, " and ", __`
	`          Filling2, " on ", Bread[Index], " bread."`
	
	`ENDPROCEDURE`
	
	Mark as follows:
	MP1 Loop for Filling 1, avoiding unused elements
	MP2 Loop for Filling 2 avoiding unused elements
	MP3 Check Filling 2 is different from Filling 1 – could correctly compare either the indices or the array contents
	
	MP4 Loop for Bread, avoiding unused elements
	
	MP5 Using `RAND(10) / RAND(35)`
	MP6 Completely correct use of `RAND()` – including `INT()` and +1 in all cases
	
	MP7 Correct output - **once only** – following a reasonable attempt at selection of filings and bread
		7

6(b)	Answers include: **MP1** For each filling, create a list of acceptable / incompatible fillings/indexes **MP2** When selecting the second filling, (as well as checking for an unused element) check that the filling / index is / is not on the list ALTERNATIVE: **MP1** Create a list of 'good' combinations **MP2** Randomly select from this list	2

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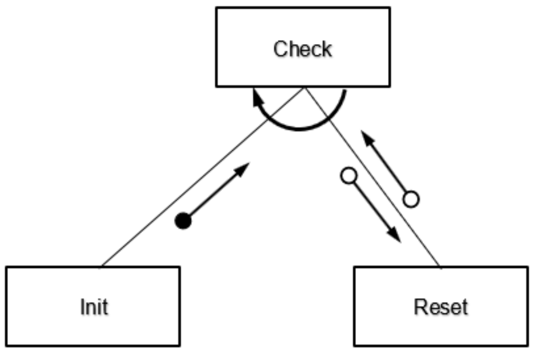
Question	Answer	Marks
7(a)	• Customer ID – to reference the other customer details • Email address – to send the email • Name – to personalise the email • Date of last visit – to select which customers should receive an email • Unique voucher code (or method of code generation) – to include in the email Mark as follows: One mark per item **and** justification **Max 3 marks**	**3**
7(b)	Abstraction	**1**
7(c)	**MP1** Data structures // data dictionary // identifier table(s) // validation rules **MP2** Data-flow diagram // state-transition diagram **MP3** User interface // Format for the email **MP4** Testing method / Test plan / Test data / Trace tables **MP5** Choice of email protocol to be used // Programming language to be used // Development environment **MP6** Use of library routines // program to send the email **Max 3 marks**	**3**
7(d)	 **MP1** Three boxes correctly labelled **and** correct hierarchy **MP2** Parameter **and** return values **MP3** Iteration arrow	**3**

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Question	Answer	Marks

8(a)	Example solution:
	```
	PROCEDURE Assign(ThisRole : STRING, ThisPlayer : INTEGER)
	   DECLARE Index : INTEGER
	   DECLARE Done : BOOLEAN

	   Done ← FALSE
	   Index ← 1

	   WHILE Index < 46 AND Done = FALSE
	      IF Character[Index].Player = 0 AND __
	         Character[Index].Role = ThisRole THEN
	         Character[Index].Player ← ThisPlayer
	         Done ← TRUE
	      ELSE
	         Index ← Index + 1
	      ENDIF
	   ENDWHILE

	   IF Done = TRUE THEN
	      OUTPUT Character[Index].Name, " the ",__
	             Character[Index].Role, __
	             " has been assigned to player ", ThisPlayer
	   ELSE
	      OUTPUT "No characters with this role are available"
	   ENDIF

	ENDPROCEDURE
	```
	Mark as follows:
	MP1 Loop until 'found' or all 45 elements considered
	MP2 Test of `Player` field – i.e. not value **in a loop**
	
	MP3 ... `AND Role` **–** i.e. match for **`ThisRole`** parameter **in a loop**
	
	MP4 If available character found, assign `ThisPlayer` to the character **in a loop**
	MP5 When character found set termination condition/flag
	MP6 **Both** OUTPUT messages logically correctly placed
	
	MP7 **Both** OUTPUT statements correctly formed
		7

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Question	Answer	Marks

8(b)	Example solution:
	
	`PROCEDURE Save()`
	`   DECLARE Index    : INTEGER`
	`   DECLARE Line     : STRING`
	`   CONSTANT SEP = '^'`
	
	`   OPENFILE "SaveFile.txt" FOR WRITE`
	`   FOR Index ← 1 TO 45`
	`      Line ← NUM_TO_STR(Character[Index].Player) & SEP`
	`      Line ← Line & Character[Index].Role & SEP`
	`      Line ← Line & Character[Index].Name & SEP`
	`      Line ← Line & NUM_TO_STR(Character[Index].Level)`
	`      WRITEFILE "SaveFile.txt", Line`
	`   NEXT Index`
	
	`   CLOSEFILE "SaveFile.txt"`
	`ENDPROCEDURE`
	
	Mark as follows:
	MP1 Declaration of local integer for `Index` (**and** string type for `Line`)
	MP2 Open `"SaveFile.txt"` in write mode **and** subsequently close
	MP3 Loop through 45 elements
	
	MP4 Attempt to form `Line` - four fields **in a loop**
	MP5 Correct use of `NUM_TO_STR()x2 (Player and Level)` **in a loop**
	MP6 Correct use of **three** &<separator>& `strings` **in a loop**
	
	MP7 Line from MP4 written to file **in a loop**
		7

8(c)	**MP1** Encode `Status` as a character / string **MP2** Append the '^' separator and the character/string	2
8(d)	**MP1** Method: Create a filename **suffix** which is **incremented** for each file save **MP2** Example: SaveFile01.txt, SaveFile02.txt	2

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