



# Cambridge International AS & A Level

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**COMPUTER SCIENCE****9618/21**

Paper 2 Problem Solving &amp; Programming Skills

**May/June 2021**

MARK SCHEME

Maximum Mark: 75

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**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.

Cambridge International is publishing the mark schemes for the May/June 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

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This document consists of **16** printed pages.

**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.

**GENERIC MARKING PRINCIPLE 5:**

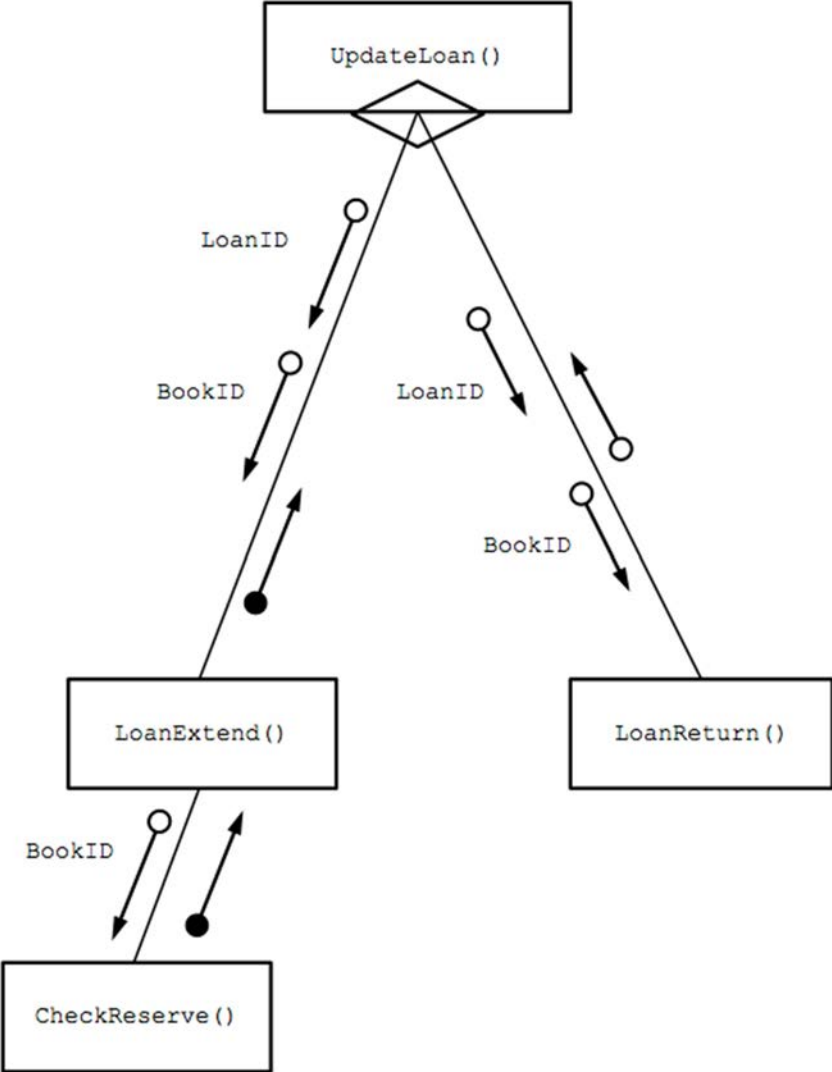
Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

**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.

Question	Answer				Marks
1(a)	<b>Example value</b>	<b>Explanation</b>	<b>Variable name</b>	<b>Data type</b>	4
"Wong"	The preferred name of the member joining the football club	<b>MemberName</b>	<b>STRING</b>		
FALSE	A value to indicate whether an existing member of the club lives at the same address	<b>FamilyMember</b>	<b>BOOLEAN</b>		
19/02/1983	When the member joined the football club	<b>StartDate</b>	<b>DATE</b>		
1345	The number of points a member has earned. Members of the club earn points for different activities.	<b>Points</b>	<b>INTEGER</b>		
One mark for each appropriate variable name plus data type					
1(b)	<b>Statement</b>		<b>Error</b>		5
Result ← 2 & 4	Should be arithmetic operator (not &) // 2 and 4 should be CHAR / STRING				
SubString ← MID("pseudocode", 4, 1)	NO ERROR				
IF x = 3 OR 4 THEN	Not Boolean values / incorrect operator // Condition incorrect				
Result ← Status AND INT(X/2)	INT(X/2) doesn't evaluate to a boolean value / incorrect operator				
Message ← "Done" + LENGTH(MyString)	Can't add string to number / "Done" is not a number				
One mark for each row					

Question	Answer	Marks
1(c)	<p>Structure:</p> <ul style="list-style-type: none"><li>Record</li></ul> <p>Justification:</p> <ul style="list-style-type: none"><li>Allows different data <u>types</u></li><li>to be stored under one <u>identifier</u></li></ul> <p>Mark as follows: One mark for Structure Two marks for justification.</p> <p><b>Alternative</b></p> <ul style="list-style-type: none"><li>Two (1D) arrays</li><li>One of string, one of integer</li><li>Where same index links the name with the score</li></ul>	<b>3</b>

Question	Answer	Marks
2(a)	 <p>One mark for:</p> <ol style="list-style-type: none"> <li>1 All four boxes correctly labelled and positioned</li> <li>2 Selection diamond (only on UpdateLoan and no iteration arrows)</li> <li>3 Parameters to and from LoanExtend ( )</li> <li>4 Parameters to and from CheckReserve ( )</li> <li>5 Parameters to and from LoanReturn ( )</li> </ol>	5
2(b)	<p><u>PROCEDURE LoanReturn (LoanID, BookID : STRING,</u>  <u>BYREF Fine : REAL)</u></p> <p>One mark for each underlined part</p>	2

Question	Answer	Marks
2(c)	<p>Example solution:</p> <pre> graph TD     Start([START]) --&gt; Input[/INPUT Num/]     Input --&gt; SetMax[Set Max to Num]     SetMax --&gt; SetTotal[Set Total to Num]     SetTotal --&gt; SetCount[Set Count to 2]     SetCount --&gt; IsCount{Is Count = 51?}     IsCount -- YES --&gt; SetAv[Set Av to (Total - Max) / 49]     SetAv --&gt; Output[/OUTPUT Max, Av/]     Output --&gt; End([END])     IsCount -- NO --&gt; Input2[/INPUT Num/]     Input2 --&gt; SetTotal2[Set Total to Total + Num]     SetTotal2 --&gt; IsMax{Is Num &gt; Max?}     IsMax -- YES --&gt; SetMax2[Set Max to Num]     IsMax -- NO --&gt; IncCount[Increment Count]     SetMax2 --&gt; IncCount     IncCount --&gt; IsCount     </pre> <p>One mark for each functional group as listed below:</p>	6

Question	Answer	Marks
2(c)	<p>Explanation of mark points:</p> <ol style="list-style-type: none"> <li>1 Initialise MAX to first value input</li> <li>2 Set Total to zero</li> <li>3 Input 49 more values (or 50 values in total)</li> <li>4 Sum all values input</li> <li>5 Set new MAX when Input value &gt; MAX <b>in a loop</b></li> <li>6 Sum all but largest (or subtract MAX from total), calculate and output average</li> </ol>	

Question	Answer	Marks
3(a)(i)	<p>One mark per bullet point:</p> <ul style="list-style-type: none"> <li>• Data from the arrays is written to the <u>files</u> at the end of the day / before the program is terminated / computer is switched off</li> <li>• Data can then be read from the <u>files</u> at the start of the next day and written to / stored in the <u>arrays</u></li> <li>• No need to (re-)enter the data manually // only need to enter data once</li> </ul> <p><b>Note: Max 2 marks</b></p>	<b>2</b>
3(a)(ii)	<ul style="list-style-type: none"> <li>• The data is retained when the program is terminated / after the computer is switched off // data is stored permanently // non-volatile storage</li> </ul>	<b>1</b>
3(a)(iii)	<p>One mark per bullet point:</p> <ul style="list-style-type: none"> <li>• Data items are combined to form a single string / saved as a single line in the file</li> <li>• Data items are separated by a special character // make each data item a fixed length</li> </ul> <p>ALTERNATIVE:</p> <ul style="list-style-type: none"> <li>• Convert all data items / 'number of people' to strings</li> <li>• Consecutive / each line stores a separate data item</li> </ul>	<b>2</b>

Question	Answer	Marks
3(b)	<pre> PROCEDURE Preview (ThisFile : STRING)   DECLARE LineNum : INTEGER   DECLARE ThisLine : STRING    OPENFILE ThisFile FOR READ   IF EOF(ThisFile) THEN     OUTPUT "Warning Message"   ELSE     LineNum ← 1     WHILE LineNum &lt; 6 AND NOT EOF(ThisFile)       READFILE Thisfile, ThisLine       OUTPUT ThisLine       LineNum ← LineNum + 1     ENDWHILE   ENDIF   CLOSEFILE ThisFile ENDPROCEDURE </pre> <p>Marks as follows:</p> <ol style="list-style-type: none"> <li>1 Procedure heading (including parameter) and ending</li> <li>2 File <b>OPEN</b> and subsequently <b>CLOSE</b></li> <li>3 Check if file is empty <b>and</b> output a warning message if it is</li> <li>4 Conditional Loop</li> <li>5 Output line (including blank lines) and read next line <b>in a loop</b></li> </ol>	<b>5</b>



Question	Answer					Marks	
4(a)	Name	Flag	Index	NewName	ThisChar	5	
	"VinVaVVcup"						
		TRUE	1	"	"		
					'∇'		
				"∇"			
		FALSE	2		'i'		
			3		'n'		
				"∇In"			
			4		'∇'		
		TRUE		"∇In∇"			
			5		'a'		
		FALSE		"∇InVA"			
		6		'∇'			
	TRUE		"∇InVA∇"				
		7		'∇'			
			"∇InVA∇∇"				
		8		'c'			
	FALSE		"∇InVA∇∇c"				
		9		'u'			
			"∇InVA∇∇Cu"				
		10		'p'			
			"∇InVA∇∇Cup"				
	FALSE	11	"∇InVA∇∇Cup"	'p'			
Mark as follows: <ul style="list-style-type: none"> <li>• One mark for each of columns 2 to 5 (condone missing final 11)</li> <li>• One mark for final row all correct (including final 11)</li> </ul>							

Question	Answer	Marks
4(b)	Loop structure: A count-controlled loop Justification: The number of iterations is known One mark per point	<b>2</b>
4(c)(i)	A couple of solutions: <pre>24  ThisChar ← LCASE(MID(Name, Index, 1))</pre> ALTERNATIVE: <pre>31  NewName ← NewName &amp; LCASE(ThisChar)</pre> Ignore line number	<b>1</b>
4(c)(ii)	One mark for each: Line number: 26 New position: Move to after line 27 / line 28	<b>2</b>

Question	Answer	Marks
5	<pre> PROCEDURE Sort()   DECLARE Temp : INTEGER   DECLARE NoSwaps : BOOLEAN   DECLARE Boundary, Row, Col : INTEGER    Boundary ← 999   REPEAT     NoSwaps ← TRUE     FOR Row ← 1 TO Boundary       IF Result[Row, 2] &gt; Result[Row + 1, 2] THEN         FOR Col ← 1 TO 2           Temp ← Result [Row, Col]           Result [Row, Col] ← Result [Row + 1, Col]           Result [Row + 1, Col] ← Temp         NEXT Col         NoSwaps ← FALSE       ENDIF     NEXT J     Boundary ← Boundary - 1   UNTIL NoSwaps = TRUE  ENDPROCEDURE </pre> <p>Mark as follows:</p> <ol style="list-style-type: none"> <li>1 Outer loop</li> <li>2 Inner loop</li> <li>3 Correct comparison <b>in a loop</b></li> <li>4 Correct swap of col1 array elements <b>in a loop</b></li> <li>5 Correct swap of col2 array elements <b>in a loop</b> (via loop or separate statements)</li> <li>6 'NoSwap' mechanism: Conditional outer loop including flag reset</li> <li>7 'NoSwap' mechanism: Set flag in inner loop to indicate swap</li> <li>8 Reducing Boundary <b>in the <u>outer</u> loop</b></li> </ol>	8

Question	Answer	Marks
6(a)	<p>One mark per point:</p> <ol style="list-style-type: none"> <li>1 Check for a free node</li> <li>2 Search for correct insertion point</li> <li>3 Assign data value B to first node in free list / node pointed to by start pointer of free list</li> <li>4 Pointer from A will be changed to point to node containing B (instead of C)</li> <li>5 Pointer from B will be changed to point to node containing C</li> <li>6 Start pointer in free list moved to point to next free node</li> </ol> <p><b>Note: max 4 marks</b></p>	4

Question	Answer	Marks
6(b)	<p>One mark per point:</p> <ul style="list-style-type: none"><li>• An array (1D) to store the data <b>and</b> a second array (1D) to store the pointers</li><li>• An (integer) variable to hold the start pointer <b>and</b> an (integer) variable to store the next free pointer</li></ul> <p>ALTERNATIVE:</p> <ul style="list-style-type: none"><li>• Define a record type comprising a data element and a pointer <b>and</b> declare an array (1D) of this type</li><li>• An integer variable to hold the start pointer <b>and</b> an integer variable to store the next free pointer</li></ul>	<b>2</b>

Question	Answer	Marks
7(a)	<pre> FUNCTION GetStart (WordNum : INTEGER) RETURNS INTEGER   DECLARE Index, ThisPos, NumFound : INTEGER   DECLARE ThisChar : Char    CONSTANT SPACECHAR = ' '    Index ← -1   Numfound ← 0   ThisPos ← 1    IF WordNum = 1 THEN // if looking for word 1...     Index ← 1 // Word 1 always starts at index                 // position 1   ELSE     // Otherwise start counting spaces...     WHILE ThisPos &lt;= LENGTH(FNString) AND Index = -1       ThisChar ← MID(FNString, ThisPos, 1)       IF ThisChar = SPACECHAR THEN         NumFound ← NumFound + 1         IF NumFound = WordNum - 1 THEN           Index ← ThisPos + 1 // the start of the                               // required word         ENDIF       ENDIF       ThisPos ← ThisPos + 1     ENDWHILE   ENDIF RETURN Index  ENDFUNCTION </pre> <p>1 mark for each of the following:</p> <ol style="list-style-type: none"> <li>1 Function heading, including return type and function end</li> <li>2 Loop counting spaces until word found or end of FNString</li> <li>3 extract a character from FNString <b>in a loop</b></li> <li>4 compare with SPACECHAR <b>and</b> increment count if equal <b>in a loop</b></li> <li>5 compare count with WordNum - 1 (depending on initialisation value) <b>in a loop</b></li> <li>6 if equal then set flag or Index to ThisPos + 1 <b>in a loop</b></li> <li>7 Return Index (correctly in all cases / following a reasonable attempt)</li> <li>8 Works for special case when looking for word 1</li> </ol> <p><b>Note: Max 7 marks</b></p>	7

Question	Answer	Marks
7(b)	<p>Marks awarded for any reference to each of the following steps of the algorithm:</p> <ol style="list-style-type: none"> <li>1 Mention of variable for use as array index</li> <li>2 Use of a loop (to check through the array)</li> <li>3 If word is the same as the current array element then return <code>FALSE</code> / set flag</li> <li>4 If word not already in array, loop to find unused element (<i>second loop</i>)</li> <li>5 Store word in unused element and return <code>TRUE</code>, otherwise return <code>FALSE</code></li> </ol> <p>VARIATION:</p> <ol style="list-style-type: none"> <li>1 Mention of variable for use as array index</li> <li>2 Use of a loop (to check through the array)</li> <li>3 Save index of (first) unused element found</li> <li>4 If word is the same as the current array element then return <code>FALSE</code> / set flag</li> <li>5 If word not already in array <b>and</b> unused element available, store word in unused element and return <code>TRUE</code> otherwise return <code>FALSE</code></li> </ol> <p><b>Note: Max 4 marks</b></p>	<b>4</b>

Question	Answer	Marks
7(c)	<pre> FUNCTION GetWord (Index : INTEGER) RETURNS STRING    DECLARE NextWord : STRING   DECLARE Done : BOOLEAN   DECLARE ThisChar : CHAR   DECLARE Index : INTEGER    CONSTANT SPACECHAR = ' '    NextWord ← ""   Done ← FALSE    REPEAT     ThisChar ← MID(FNString, Index, 1)     IF ThisChar &lt;&gt; SPACECHAR THEN       NextWord ← NextWord &amp; ThisChar // build up NextWord     ENDIF     IF ThisChar = SPACECHAR OR Index = LENGTH(FNString) THEN       Done ← TRUE     ENDIF      Index ← Index + 1    UNTIL Done = TRUE  RETURN NextWord  ENDFUNCTION </pre> <p>1 mark for each of the following:</p> <ol style="list-style-type: none"> <li>1 Conditional loop</li> <li>2 Extract char from FNString and compare with SPACECHAR <b>in a loop</b></li> <li>3 Concatenate with NextWord if not SPACECHAR <b>in a loop</b></li> <li>4 Exit loop when SPACECHAR encountered <b>or</b> when end of FNString reached</li> <li>5 Return NextWord (after reasonable attempt at forming, and must have been initialised)</li> </ol>	<b>5</b>

Question	Answer	Marks
7(c)	<p>The 'length and substring' solution:</p> <pre> FUNCTION GetWord (Index : INTEGER) RETURNS STRING   DECLARE Done : BOOLEAN   DECLARE ThisChar : CHAR   DECLARE Index, NextPos : INTEGER    CONSTANT SPACECHAR = ' '    Done ← FALSE   NextPos ← Index // must be at least one character in                   // the required word    REPEAT     ThisChar ← MID(FNString, NextPos, 1)     IF ThisChar = SPACECHAR OR NextPos =                                 LENGTH(FNString) THEN       Done ← TRUE     ELSE       NextPos ← NextPos + 1     ENDIF   UNTIL Done = TRUE    IF NextPos = LENGTH(FNString) THEN     NextPos ← NextPos - 1 // special case when last word   ENDIF    RETURN MID(FNString, Index, NextPos - Index)  ENDFUNCTION </pre> <p>1 mark for each of the following:</p> <ol style="list-style-type: none"> <li>1 Conditional loop</li> <li>2 ...extract char from FNString and compare with SPACECHAR <b>in a loop</b></li> <li>3 .. increment count if word continues</li> <li>4 Exit loop when SPACECHAR encountered <b>or</b> when end of FNString reached</li> <li>5 Apply substring function and Return</li> </ol>	