



Cambridge International AS & A Level

COMPUTER SCIENCE

9618/23

Paper 2 Problem Solving & Programming Skills

May/June 2021

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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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:

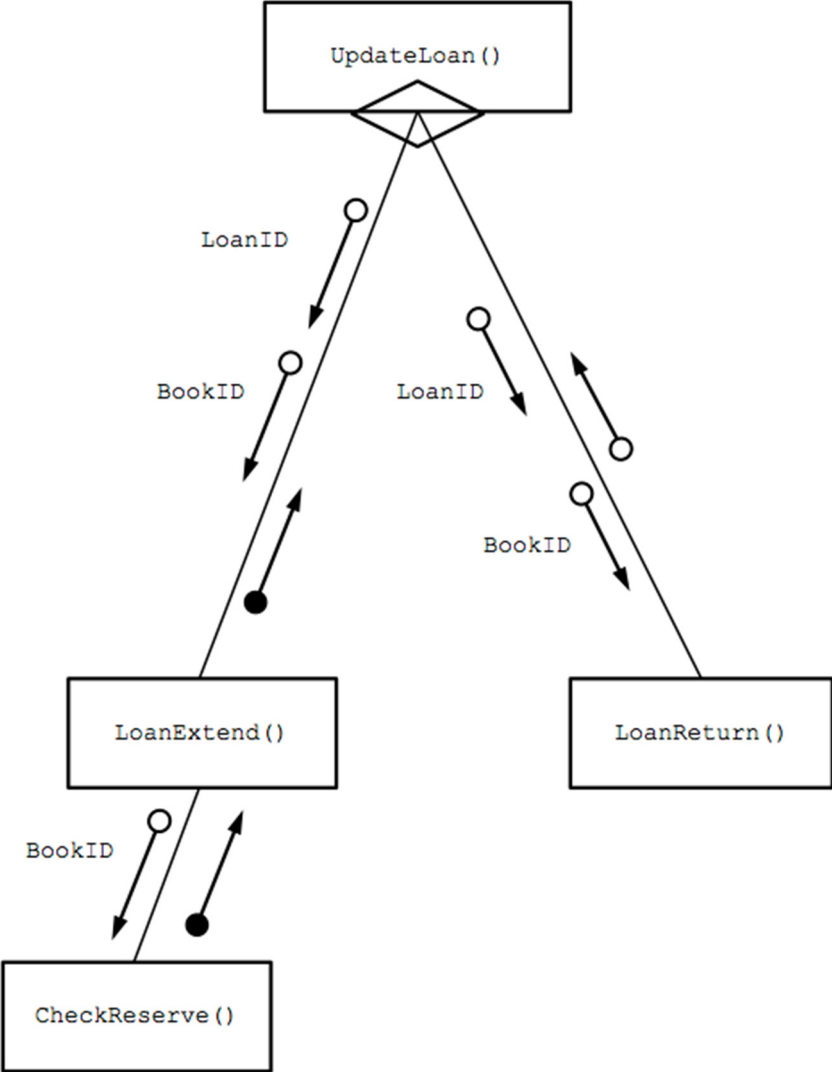
Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

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)	Example value	Explanation	Variable name	Data type	4								
"Wong"	The preferred name of the member joining the football club	MemberName	STRING										
FALSE	A value to indicate whether an existing member of the club lives at the same address	FamilyMember	BOOLEAN										
19/02/1983	When the member joined the football club	StartDate	DATE										
1345	The number of points a member has earned. Members of the club earn points for different activities.	Points	INTEGER										
One mark for each appropriate variable name plus data type													
1(b)	Statement		Error						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">• Record <p>Justification:</p> <ul style="list-style-type: none">• Allows different data <u>types</u>• to be stored under one <u>identifier</u> <p>Mark as follows: One mark for Structure Two marks for justification.</p> <p>Alternative</p> <ul style="list-style-type: none">• Two (1D) arrays• One of string, one of integer• Where same index links the name with the score	3

Question	Answer	Marks
2(a)	 <p>UML class diagram showing UpdateLoan() as a selection diamond. It is connected to LoanExtend(), LoanReturn(), and CheckReserve(). LoanExtend() is connected to CheckReserve(). Parameters LoanID and BookID are shown on the associations.</p> <p>One mark for:</p> <ol style="list-style-type: none"> 1 All four boxes correctly labelled and positioned 2 Selection diamond (only on UpdateLoan and no iteration arrows) 3 Parameters to and from LoanExtend() 4 Parameters to and from CheckReserve() 5 Parameters to and from LoanReturn() 	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]) --> Input[/INPUT Num/] Input --> SetMax[Set Max to Num] SetMax --> SetTotal[Set Total to Num] SetTotal --> SetCount[Set Count to 2] SetCount --> IsCount{Is Count = 51?} IsCount -- YES --> SetAv[Set Av to (Total - Max) / 49] SetAv --> Output[/OUTPUT Max, Av/] Output --> End([END]) IsCount -- NO --> Input2[/INPUT Num/] Input2 --> SetTotal2[Set Total to Total + Num] SetTotal2 --> IsMax{Is Num > Max?} IsMax -- YES --> SetMax2[Set Max to Num] IsMax -- NO --> IncCount[Increment Count] SetMax2 --> IncCount IncCount --> 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"> 1 Initialise MAX to first value input 2 Set Total to zero 3 Input 49 more values (or 50 values in total) 4 Sum all values input 5 Set new MAX when Input value > MAX in a loop 6 Sum all but largest (or subtract MAX from total), calculate and output average 	

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

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 < 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"> 1 Procedure heading (including parameter) and ending 2 File <code>OPEN</code> and subsequently <code>CLOSE</code> 3 Check if file is empty and output a warning message if it is 4 Conditional Loop 5 Output line (including blank lines) and read next line in a loop 	5

Question	Answer					Marks																																																																																																																								
4(a)	<table border="1"> <thead> <tr> <th data-bbox="290 248 560 309">Name</th> <th data-bbox="560 248 711 309">Flag</th> <th data-bbox="711 248 863 309">Index</th> <th data-bbox="863 248 1147 309">NewName</th> <th data-bbox="1147 248 1337 309">ThisChar</th> </tr> </thead> <tbody> <tr> <td data-bbox="290 309 560 376">"∇in∇a∇∇Cup"</td> <td data-bbox="560 309 711 376"></td> <td data-bbox="711 309 863 376"></td> <td data-bbox="863 309 1147 376"></td> <td data-bbox="1147 309 1337 376"></td> </tr> <tr> <td data-bbox="290 376 560 443"></td> <td data-bbox="560 376 711 443">TRUE</td> <td data-bbox="711 376 863 443">1</td> <td data-bbox="863 376 1147 443">"</td> <td data-bbox="1147 376 1337 443"></td> </tr> <tr> <td data-bbox="290 443 560 510"></td> <td data-bbox="560 443 711 510"></td> <td data-bbox="711 443 863 510"></td> <td data-bbox="863 443 1147 510"></td> <td data-bbox="1147 443 1337 510">'∇'</td> </tr> <tr> <td data-bbox="290 510 560 577"></td> <td data-bbox="560 510 711 577"></td> <td 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<p>Mark as follows:</p> <ul style="list-style-type: none"> • One mark for each of columns 2 to 5 (condone missing final 11) • One mark for final row all correct (including final 11) 																																																																																																																														

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

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] > 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"> 1 Outer loop 2 Inner loop 3 Correct comparison in a loop 4 Correct swap of col1 array elements in a loop 5 Correct swap of col2 array elements in a loop (via loop or separate statements) 6 'NoSwap' mechanism: Conditional outer loop including flag reset 7 'NoSwap' mechanism: Set flag in inner loop to indicate swap 8 Reducing Boundary in the <u>outer</u> loop 	8

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

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

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 <= 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"> 1 Function heading, including return type and function end 2 Loop counting spaces until word found or end of FNString 3 extract a character from FNString in a loop 4 compare with SPACECHAR and increment count if equal in a loop 5 compare count with WordNum - 1 (depending on initialisation value) in a loop 6 if equal then set flag or Index to ThisPos + 1 in a loop 7 Return Index (correctly in all cases / following a reasonable attempt) 8 Works for special case when looking for word 1 <p>Note: Max 7 marks</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"> 1 Mention of variable for use as array index 2 Use of a loop (to check through the array) 3 If word is the same as the current array element then return <code>FALSE</code> / set flag 4 If word not already in array, loop to find unused element (<i>second loop</i>) 5 Store word in unused element and return <code>TRUE</code>, otherwise return <code>FALSE</code> <p>VARIATION:</p> <ol style="list-style-type: none"> 1 Mention of variable for use as array index 2 Use of a loop (to check through the array) 3 Save index of (first) unused element found 4 If word is the same as the current array element then return <code>FALSE</code> / set flag 5 If word not already in array and unused element available, store word in unused element and return <code>TRUE</code> otherwise return <code>FALSE</code> <p>Note: Max 4 marks</p>	4

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 <> SPACECHAR THEN NextWord ← NextWord & 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"> 1 Conditional loop 2 Extract char from FNString and compare with SPACECHAR in a loop 3 Concatenate with NextWord if not SPACECHAR in a loop 4 Exit loop when SPACECHAR encountered or when end of FNString reached 5 Return NextWord (after reasonable attempt at forming, and must have been initialised) 	5

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"> 1 Conditional loop 2 ...extract char from FNString and compare with SPACECHAR in a loop 3 .. increment count if word continues 4 Exit loop when SPACECHAR encountered or when end of FNString reached 5 Apply substring function and Return 	