



Cambridge International AS & A Level

SUBJECT**9618/22**

Paper 22 Fundamental Problem Solving & Programming Skills

May/June 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.

Cambridge International is publishing the mark schemes for the May/June 2022 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **14** 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.

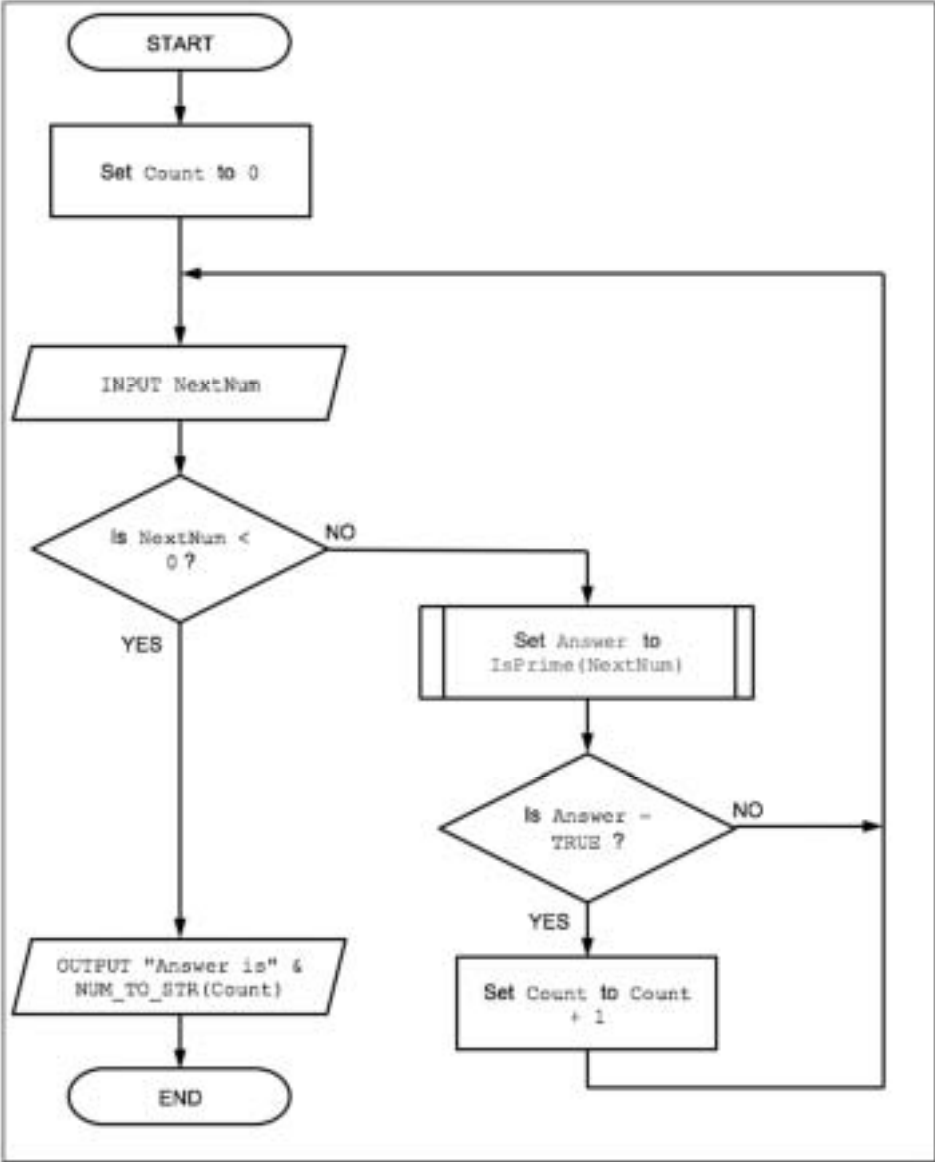
GENERIC MARKING PRINCIPLE 5:

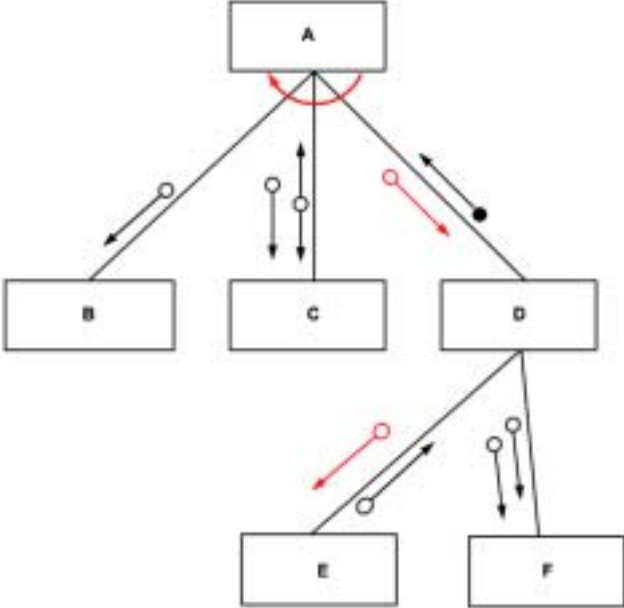
Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

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)	Correct answer only: Breakpoint	1										
1(b)	One mark per row <table border="1" data-bbox="264 448 1366 808"> <thead> <tr> <th data-bbox="264 448 1091 512">Activity</th> <th data-bbox="1091 448 1366 512">Life cycle stage</th> </tr> </thead> <tbody> <tr> <td data-bbox="264 512 1091 577">An identifier table is produced.</td> <td data-bbox="1091 512 1366 577">Design</td> </tr> <tr> <td data-bbox="264 577 1091 642">Syntax errors can occur.</td> <td data-bbox="1091 577 1366 642">Coding</td> </tr> <tr> <td data-bbox="264 642 1091 741">The developer discusses the program requirements with the customer.</td> <td data-bbox="1091 642 1366 741">Analysis</td> </tr> <tr> <td data-bbox="264 741 1091 808">A trace table is produced.</td> <td data-bbox="1091 741 1366 808">Testing</td> </tr> </tbody> </table>	Activity	Life cycle stage	An identifier table is produced.	Design	Syntax errors can occur.	Coding	The developer discusses the program requirements with the customer.	Analysis	A trace table is produced.	Testing	4
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Syntax errors can occur.	Coding											
The developer discusses the program requirements with the customer.	Analysis											
A trace table is produced.	Testing											
1(c)	One mark per bullet point to Max 2 <ul style="list-style-type: none"> • A description of what the identifier is used for / the purpose of the identifier • The data type of the identifier • The number of elements of an <u>array</u> // the length of a <u>string</u> • An <u>example</u> data value • Value of any constants used • The scope of the variable (local or global) 	2										
1(d)	One mark per row <table border="1" data-bbox="272 1218 1358 1713"> <thead> <tr> <th data-bbox="272 1218 754 1283">Statement</th> <th data-bbox="754 1218 1358 1283">Error</th> </tr> </thead> <tbody> <tr> <td data-bbox="272 1283 754 1348">Status ← TRUE AND FALSE</td> <td data-bbox="754 1283 1358 1348">NO ERROR</td> </tr> <tr> <td data-bbox="272 1348 754 1451">IF LENGTH("Password") < "10" THEN</td> <td data-bbox="754 1348 1358 1451">"10" shouldn't be a string // must be an integer</td> </tr> <tr> <td data-bbox="272 1451 754 1617">Code ← LCASE("Electrical")</td> <td data-bbox="754 1451 1358 1617">Parameter must be a char // cannot be a string Alternative: LCASE should be TO_LOWER</td> </tr> <tr> <td data-bbox="272 1617 754 1713">Result ← IS_NUM(-27.3)</td> <td data-bbox="754 1617 1358 1713">Parameter must be a string / char // cannot be a number</td> </tr> </tbody> </table>	Statement	Error	Status ← TRUE AND FALSE	NO ERROR	IF LENGTH("Password") < "10" THEN	"10" shouldn't be a string // must be an integer	Code ← LCASE("Electrical")	Parameter must be a char // cannot be a string Alternative: LCASE should be TO_LOWER	Result ← IS_NUM(-27.3)	Parameter must be a string / char // cannot be a number	4
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Question	Answer	Marks
2	 <pre> graph TD Start([START]) --> SetCount[Set Count to 0] SetCount --> Input[/INPUT NextNum/] Input --> IsNextNum{Is NextNum < 0?} IsNextNum -- YES --> Output[/OUTPUT "Answer is" & NUM_TO_STR(Count)/] Output --> End([END]) IsNextNum -- NO --> SetAnswer[Set Answer to IsPrime(NextNum)] SetAnswer --> IsAnswer{Is Answer = TRUE?} IsAnswer -- YES --> SetCountPlus[Set Count to Count + 1] SetCountPlus --> Input IsAnswer -- NO --> IsNextNum </pre> <p>One mark per point:</p> <ol style="list-style-type: none"> 1 Initialise Count before loop AND Input NextNum in a loop 2 Loop until NextNum < 0 AND OUTPUT statement including Count plus a message 3 Use of IsPrime(NextNum) as a function (must return a value) 4 Check return value AND increment Count if appropriate 	4

Question	Answer	Marks														
3(a)(i)	<p>One mark per red annotation</p> 	3														
3(a)(ii)	<table border="1" data-bbox="261 954 679 1406"> <thead> <tr> <th>Label</th> <th>Module name</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>Head</td> </tr> <tr> <td>B</td> <td>Mod_W</td> </tr> <tr> <td>C</td> <td>Mod_X</td> </tr> <tr> <td>D</td> <td>Mod_V</td> </tr> <tr> <td>E</td> <td>Mod-Z</td> </tr> <tr> <td>F</td> <td>Mod_Y</td> </tr> </tbody> </table> <p>Marks as follows:</p> <ul style="list-style-type: none"> • Two rows correct – one mark • Four rows correct – two marks • All rows correct – three marks 	Label	Module name	A	Head	B	Mod_W	C	Mod_X	D	Mod_V	E	Mod-Z	F	Mod_Y	3
Label	Module name															
A	Head															
B	Mod_W															
C	Mod_X															
D	Mod_V															
E	Mod-Z															
F	Mod_Y															
3(b)	<p>One mark per point:</p> <ul style="list-style-type: none"> • Breaking a complex problem down makes it easier to understand / solve // smaller problems are easier to understand / solve • Smaller problems are easier to program / test / maintain • Sub-problems can be given to different teams / programmers with different expertise // can be solved separately 	3														

Question	Answer	Marks
4(a)	<pre> PROCEDURE LastLines(ThisFile : STRING) DECLARE ThisLine, LineX, LineY, LineZ : STRING OPENFILE ThisFile FOR READ LineY ← "" LineZ ← "" WHILE NOT EOF(ThisFile) READFILE Thisfile, ThisLine // read a line LineX ← LineY LineY ← LineZ LineZ ← ThisLine ENDWHILE CLOSEFILE ThisFile OUTPUT LineX OUTPUT LineY OUTPUT LineZ ENDPROCEDURE </pre> <p>Marks as follows to Max 6:</p> <ol style="list-style-type: none"> 1 Procedure heading (including parameter) and ending 2 Declaration of local variables for three lines AND File OPEN in READ mode AND CLOSE 3 Loop until EOF(ThisFile) 4 Read line from file... in a loop 5 Attempt at a shuffle... in a loop 6 Correctly shuffle LineX, LineY and LineZ in a loop 7 OUTPUT the three lines in correct sequence, following reasonable attempt 	6

Question	Answer	Marks
4(a)	<p>Alternative (using two loops):</p> <pre> PROCEDURE LastLines(ThisFile : STRING) DECLARE ThisLine, LineX, LineY, LineZ : STRING DECLARE Count, Count2 : INTEGER Count ← 0 OPENFILE ThisFile FOR READ WHILE NOT EOF(ThisFile) READFILE Thisfile, ThisLine // read a line Count ← Count + 1 ENDWHILE CLOSEFILE ThisFile OPENFILE ThisFile FOR READ FOR Count2 ← 1 TO Count - 3 READFILE Thisfile, ThisLine // read a line NEXT Count2 READFILE Thisfile, LineX READFILE Thisfile, LineY READFILE Thisfile, LineZ OUTPUT LineX OUTPUT LineY OUTPUT LineZ CLOSEFILE ThisFile ENDPROCEDURE </pre> <p>Marks as follows to Max 6:</p> <ol style="list-style-type: none"> 1 Procedure heading (including parameter) and ending 2 Declaration of local variables for three lines AND (at least one) File OPEN in READ mode AND CLOSE 3 Loop until EOF(ThisFile) 4 Read line from file and increment Count in a loop 5 Two separate loops, closing and re-opening the file between loops 6 Read Count - 3 lines from the file 7 OUTPUT the last three lines in correct sequence, following reasonable attempt 	

Question	Answer	Marks
4(b)	<p>One mark per point to Max 3:</p> <ol style="list-style-type: none"> 1 Change the procedure header to include a (numeric) parameter (as well as the filename) 2 Replace <code>LineX</code>, <code>Y</code> and <code>Z</code> with an array 3 Amend shuffle mechanism 4 Use new parameter to determine first line to output 5 Output the lines in a loop <p>Alternative 'two loop' solution to Max 3:</p> <ol style="list-style-type: none"> 1 Change the procedure header to include a numeric parameter (as well as the filename) 2 A loop to count the total number of lines in the file 3 Ref use of single variable rather than <code>LineX</code>, <code>LineY</code> and <code>LineZ</code> 4 Close and re-open the file 5 Use the new parameter value to determine first line to output 6 Output the lines in a loop 	3

Question	Answer	Marks																																																																																																
5(a)	One mark for type and one mark for condition: Independent marks Type: pre-condition Condition: when the value of <code>ThisNum</code> / the input value is equal to zero	2																																																																																																
5(b)	<table border="1" data-bbox="284 483 1366 1534"> <thead> <tr> <th>ThisNum</th> <th>ThisChar</th> <th>CountA</th> <th>CountB</th> <th>Flag</th> <th>OUTPUT</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td>0</td> <td>10</td> <td>TRUE</td> <td></td> </tr> <tr> <td>12</td> <td>'1'</td> <td>1</td> <td></td> <td></td> <td></td> </tr> <tr> <td>24</td> <td>'2'</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>57</td> <td>'5'</td> <td></td> <td></td> <td></td> <td>"Ignored"</td> </tr> <tr> <td>43</td> <td>'4'</td> <td></td> <td>9</td> <td>FALSE</td> <td></td> </tr> <tr> <td>56</td> <td>'5'</td> <td>4</td> <td></td> <td></td> <td></td> </tr> <tr> <td>22</td> <td>'2'</td> <td></td> <td></td> <td>TRUE</td> <td>"Flip"</td> </tr> <tr> <td>31</td> <td>'3'</td> <td></td> <td>8</td> <td></td> <td></td> </tr> <tr> <td>32</td> <td>'3'</td> <td></td> <td>7</td> <td></td> <td></td> </tr> <tr> <td>47</td> <td>'4'</td> <td></td> <td>6</td> <td>FALSE</td> <td></td> </tr> <tr> <td>99</td> <td>'9'</td> <td></td> <td></td> <td>TRUE</td> <td>"Flip"</td> </tr> <tr> <td>0</td> <td></td> <td></td> <td></td> <td></td> <td>4</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p data-bbox="258 1570 1198 1671"> Marks as follows: One mark per outlined group If no marks per group then mark by columns (columns 3 to 6) for max 4 </p>	ThisNum	ThisChar	CountA	CountB	Flag	OUTPUT			0	10	TRUE		12	'1'	1				24	'2'					57	'5'				"Ignored"	43	'4'		9	FALSE		56	'5'	4				22	'2'			TRUE	"Flip"	31	'3'		8			32	'3'		7			47	'4'		6	FALSE		99	'9'			TRUE	"Flip"	0					4																			6
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5(c)	One mark per point: <ul data-bbox="258 1738 1273 1805" style="list-style-type: none"> • Modules that have already been tested individually • are combined into a single (sub) program which is then tested as a whole 	2																																																																																																

Question	Answer	Marks
6	<pre> PROCEDURE Parse(InString : STRING) DECLARE Count, Total, Index : INTEGER DECLARE Average : REAL DECLARE NumString : STRING DECLARE ThisChar : CHAR CONSTANT COMMA = ',' Count ← 0 Total ← 0 NumString ← "" FOR Index ← 1 to LENGTH(InString) ThisChar ← MID(InString, Index, 1) IF ThisChar = COMMA THEN Total ← Total + STR_TO_NUM(NumString) Count ← Count + 1 NumString ← "" ELSE NumString ← NumString & ThisChar // build the number string ENDIF NEXT Index // now process the final number Total ← Total + STR_TO_NUM(NumString) Count ← Count + 1 Average ← Total / Count OUTPUT "The total was ", Total, " and the average was ", Average ENDPROCEDURE </pre> <p>Marks as follows:</p> <ol style="list-style-type: none"> 1 Declare and initialise Count, Total and NumString 2 Loop for number of characters in InString 3 Extract a character and test for comma in a loop 4 If comma, convert NumString to integer and update Total and Count and reset NumString 5 Otherwise append character to NumString 6 Calculate average AND final output statement(s) outside the loop 	7

Question	Answer	Marks
7(a)	<pre> FUNCTION MID(InString : STRING, Start, Num : INTEGER) RETURNS STRING DECLARE MidString : STRING DECLARE InStringLen : INTEGER InStringLen ← LENGTH(InString) // solution for RIGHT() then LEFT() MidString ← RIGHT(InString, InStringLen - Start + 1) MidString ← LEFT(MidString, Num) // alternative solution for LEFT() then RIGHT() MidString ← LEFT(InString, Start + Num - 1) MidString ← RIGHT(MidString, Num) RETURN MidString ENDFUNCTION </pre> <p>Marks as follows:</p> <ol style="list-style-type: none"> 1 Function heading and ending including parameters and return type 2 Correct use of one substring functions 3 Correct use of both substring functions (in correct sequence) 4 Return substring after a reasonable attempt 	4
7(b)	<p>One mark per point</p> <p>Check that:</p> <ul style="list-style-type: none"> • Start and/or Num are ≥ 1 // positive • Length of InString is "sufficient" for required operation 	2

Question	Answer	Marks
8(a)	<pre> FUNCTION Exists(ThisString : STRING, Search : CHAR) RETURNS BOOLEAN DECLARE Found : BOOLEAN DECLARE Index : INTEGER Found ← FALSE Index ← 1 WHILE Found = FALSE AND Index <= LENGTH(ThisString) IF MID(ThisString, Index, 1) = Search THEN Found ← TRUE ELSE Index ← Index + 1 ENDIF ENDWHILE RETURN Found ENDFUNCTION </pre> <p>Marks as follows (Conditional loop solution):</p> <ol style="list-style-type: none"> 1 Conditional loop while character not found and not end of string 2 Extract a char in a loop 3 Compare with parameter without case conversion in a loop 4 If match found, set termination logic in a loop 5 Return BOOLEAN value <p>ALTERNATIVE (Using Count-controlled loop):</p> <pre> FOR Index ← 1 TO LENGTH(ThisString) IF MID(ThisString, Index, 1) = Search THEN RETURN TRUE ENDIF NEXT Index RETURN FALSE </pre> <p>Marks as follows (Count-controlled loop variant):</p> <ol style="list-style-type: none"> 1 Loop for length of <code>ThisString</code> (allow from 0 or 1) 2 Extract a char in a loop 3 Compare with parameter without case conversion in a loop 4 If match found, immediate RETURN of TRUE 5 Return FALSE after the loop // Return Boolean if no immediate RETURN 	5

Question	Answer	Marks
8(b)	<pre> PROCEDURE SearchDuplicates() DECLARE IndexA, IndexB : INTEGER DECLARE ThisPassword, ThisValue : STRING DECLARE Duplicates : BOOLEAN Duplicates ← FALSE IndexA ← 1 WHILE Duplicates = FALSE AND IndexA < 500 ThisValue ← Secret[IndexA, 2] IF ThisValue <> "" THEN ThisPassword ← Decrypt(ThisValue) FOR IndexB ← IndexA + 1 TO 500 // IF Secret[IndexB, 2] <> "" THEN IF Decrypt(Secret[IndexB, 2]) = ThisPassword THEN OUTPUT "Password for " & Secret[IndexA, 1] & "also used for " & Secret[IndexB, 1] Duplicates ← TRUE ENDIF ENDIF NEXT IndexB ENDIF IndexA ← IndexA + 1 ENDWHILE IF Duplicates = FALSE THEN OUTPUT "No duplicate passwords found" ENDIF ENDPROCEDURE </pre> <p>Marks as follows to Max 8:</p> <ol style="list-style-type: none"> 1. (Any) conditional loop... 2. ... from 1 to 499 while (attempt at) no duplicate 3. Skip unused password 4. Use <code>Decrypt()</code> and assign return value to <code>ThisPassword</code> 5. Inner loop from outer loop index + 1 to 500 searching for duplicates 6. Compare <code>ThisPassword</code> with subsequent passwords (after use of <code>Decrypt()</code>) 7. If match found, set outer loop termination 8. and attempt an Output message giving duplicate 9. Output 'No duplicate passwords found' message if no duplicates found after the loop 	8

Question	Answer	Marks
8(c)	<p>One mark for each point that is referenced:</p> <ol style="list-style-type: none"> 1 Initialise password to empty string at the start and return (attempted) password at the end of the function 2 Two loops to generate 3 groups of 4 characters // One loop to generate 12 / 14 characters 3 Use of <code>RandomChar()</code> to generate a character in a loop 4 Reject character if <code>Exists()</code> returns <code>TRUE</code>, otherwise form string in a loop 5 (Attempt to) use hyphens to link three groups 6 Three groups of four characters generated correctly with hyphens and without duplication (completely working algorithm) 	6