



Cambridge International AS & A Level

COMPUTER SCIENCE

9608/23

Paper 2 Fundamental Problem-solving and 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:

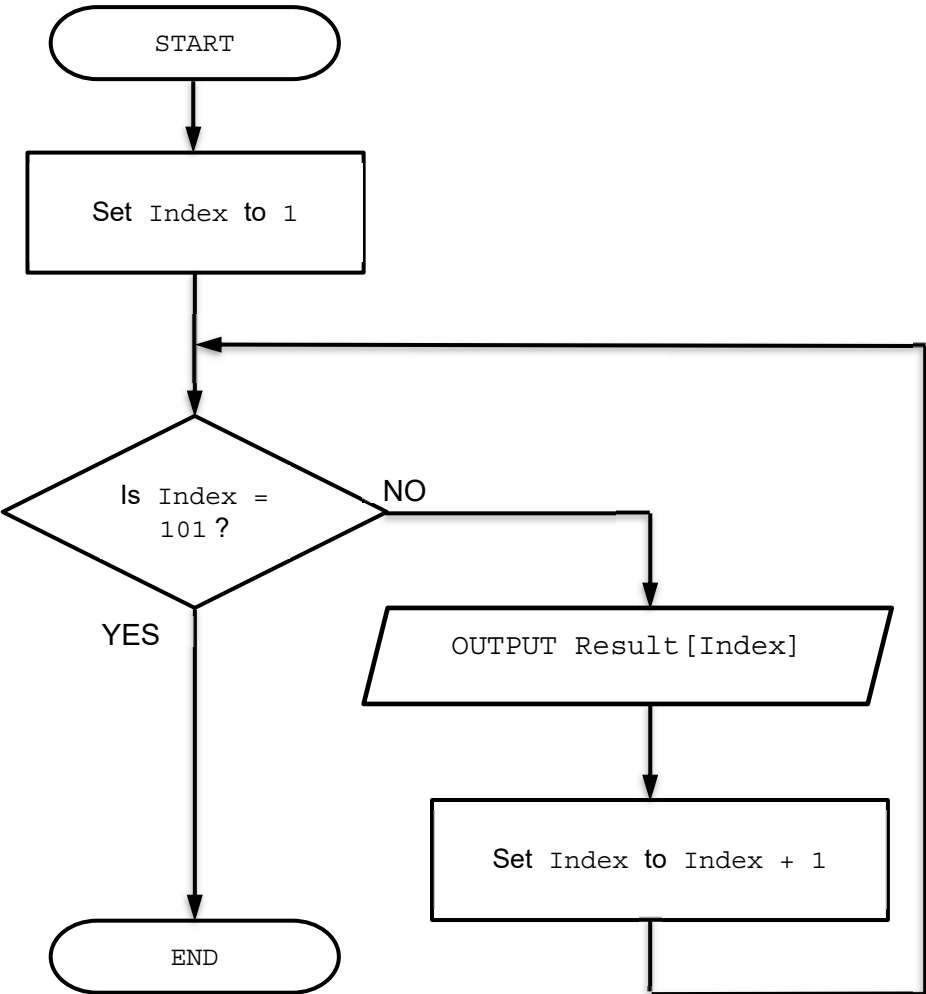
Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Question	Answer	Marks								
1(a)	<p>One mark per bullet point.</p> <ul style="list-style-type: none"> • INPUT • Example input statement in language stated • PROCESS • Example process statement in language stated • Example OUTPUT statement in language stated 	5								
1(b)(i)	<p>One mark per bullet point.</p> <ul style="list-style-type: none"> • conditional loop • the number of iterations is not known 	2								
1(b)(ii)	<p>One mark per bullet point.</p> <ul style="list-style-type: none"> • the value is found • the end of the array is reached (and value not found) 	2								
1(c)	<table border="1"> <thead> <tr> <th>Statement</th> <th>Error</th> </tr> </thead> <tbody> <tr> <td>Code ← RIGHT("Cap" * 3, 2)</td> <td>Cannot multiply a string (by 3)</td> </tr> <tr> <td>Valid ← IS_NUM(3.14159)</td> <td>Parameter should be a string</td> </tr> <tr> <td>NextChar ← MID(ThisString, Index), 1</td> <td>Closing bracket in wrong place</td> </tr> </tbody> </table> <p>One mark for each row</p>	Statement	Error	Code ← RIGHT("Cap" * 3, 2)	Cannot multiply a string (by 3)	Valid ← IS_NUM(3.14159)	Parameter should be a string	NextChar ← MID(ThisString, Index), 1	Closing bracket in wrong place	3
Statement	Error									
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Valid ← IS_NUM(3.14159)	Parameter should be a string									
NextChar ← MID(ThisString, Index), 1	Closing bracket in wrong place									

Question	Answer	Marks
2(a)	<ul style="list-style-type: none"> • (A program fault is) when the program does not do what it is supposed to do / expected to do • ... under certain circumstances <p>One mark per point or equivalent</p>	2
2(b)(i)	Makes it easier to understand the purpose of each identifier / what the identifier is used for / the purpose of the program	1

Question	Answer	Marks
2(b)(ii)	One mark per point: 1 The use of modular programming (to avoid repeated code) 2 The use of library / tried and tested subroutines 3 Good formatting to make the code easier to read (indentation, white space) 4 Use of <u>local</u> variables 5 Use of constants 6 Use of comments to explain functionality of code Max 3 marks	3
2(c)	One mark per point: <ul style="list-style-type: none"> • white box • dry-run testing / use of trace table / walk through Max 1 mark	1

Question	Answer	Marks
3(a)	<ul style="list-style-type: none"> • To break the problem down into sub-tasks • where each sub-task can be implemented by a program module / is easier to solve. One mark for each phrase (or equivalent)	2

Question	Answer	Marks
3(b)	 <pre>graph TD; START([START]) --> SetIndex[Set Index to 1]; SetIndex --> Decision{Is Index = 101?}; Decision -- YES --> END([END]); Decision -- NO --> Output[/OUTPUT Result [Index]/]; Output --> Increment[Set Index to Index + 1]; Increment --> Decision;</pre> <p>1 mark for each of the following:</p> <ol style="list-style-type: none">1 Initialise Index2 Test index for 100 elements3 End when 100 elements output4 Output, increment and repeat	4

Question	Answer	Marks
3(c)	<pre> OnLine ← FALSE WHILE Online = FALSE IF Active = TRUE THEN Call Sync() ELSE Call Reset() IF Active = FALSE THEN Call Error("No Signal") ELSE Online ← TRUE ENDIF ENDIF Call ReCheck() ENDWHILE </pre> <p>1 mark for each of the following:</p> <ol style="list-style-type: none"> 1 Initialise Online 2 WHILE .. ENDWHILE loop, terminated when Online = TRUE 3 IF Active = TRUE THEN .. ELSE .. ENDIF 4 Nested IF Active = FALSE THEN .. ELSE .. ENDIF 5 Call Sync() and Call Reset() and Call Error() and assignment to Online in appropriate place in pseudocode 6 Final call to ReCheck() in appropriate place 	6

Question	Answer	Marks																																																																																
4(a)(i)	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">Result</th> <th style="width: 25%;">Count</th> <th style="width: 25%;">Index</th> <th style="width: 25%;">NextChar</th> </tr> </thead> <tbody> <tr><td>0</td><td>1</td><td></td><td></td></tr> <tr><td>1</td><td></td><td>1</td><td>'7'</td></tr> <tr><td>2</td><td></td><td>2</td><td>'4'</td></tr> <tr><td>3</td><td></td><td>3</td><td>'.'</td></tr> <tr><td>4</td><td></td><td>4</td><td>'0'</td></tr> <tr><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td>5</td><td>'.'</td></tr> <tr><td></td><td>2</td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td></tr> <tr><td>5</td><td></td><td>6</td><td>'4'</td></tr> <tr><td>6</td><td></td><td>7</td><td>'.'</td></tr> <tr><td>7</td><td></td><td>8</td><td>'6'</td></tr> <tr><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td>9</td><td>'.'</td></tr> <tr><td></td><td>3</td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td></tr> <tr><td>8</td><td></td><td>10</td><td>'3'</td></tr> <tr><td>-1</td><td></td><td>11</td><td>'x'</td></tr> <tr><td>0</td><td></td><td>12</td><td>'2'</td></tr> </tbody> </table> <p>Note: One mark per region indicated If no marks by zone then mark by column (max 3) Values in column 4 must be in quotes</p>	Result	Count	Index	NextChar	0	1			1		1	'7'	2		2	'4'	3		3	'.'	4		4	'0'							5	'.'		2							5		6	'4'	6		7	'.'	7		8	'6'							9	'.'		3							8		10	'3'	-1		11	'x'	0		12	'2'	5
Result	Count	Index	NextChar																																																																															
0	1																																																																																	
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-1		11	'x'																																																																															
0		12	'2'																																																																															
4(a)(ii)	<p>0 (zero)</p> <p>Allow FT from final value in 'Result' column</p>	1																																																																																

Question	Answer	Marks
4(b)(i)	Final <code>IN ... ENDF</code> errors: <ul style="list-style-type: none"> • Test needs to check <code>Count AND Result</code> • Returns <code>Result</code> instead of <code>Count</code> OR <code>FOR</code> loop error: <ul style="list-style-type: none"> • The loop continues after the illegal character is detected • So the error condition (<code>Result = -1</code>) can be lost 	2
4(b)(ii)	<ul style="list-style-type: none"> • Change <code>RETURN Result</code> to <code>RETURN Count</code> • Change final if to <code>IF Count < 3 and Result <> -1</code> • Terminate the loop as soon as an illegal character is encountered Max 1 mark	1
4(c)	<ul style="list-style-type: none"> • Syntax error • Rules of the language are not followed OR <ul style="list-style-type: none"> • Run-time error • Program performs an illegal operation or enters an infinite loop 	2

Question	Answer	Marks
5(a)	<pre> FUNCTION GroupNum(TelNum, Template : STRING) RETURNS STRING DECLARE FString : STRING DECLARE Index, ThisDigit, ThisGroup : INTEGER CONSTANT SPACE = ' ' FString ← "" ThisDigit ← 1 FOR Index ← 1 TO LENGTH(Template) ThisGroup ← STRING_TO_NUM(MID(Template, Index, 1)) FString ← FString & MID(TelNum, ThisDigit, ThisGroup) FString ← FString & SPACE ThisDigit ← ThisDigit + ThisGroup ENDFOR FString ← FString & RIGHT(TelNum, LENGTH(TelNum) - ThisDigit) RETURN FString ENDFUNCTION </pre> <p>Mark as follows:</p> <ol style="list-style-type: none"> 1 Function header and end including parameters and RETURN type 2 Local variable declaration and initialisation of FString (return string) 3 Loop to go through each char of Template (each group) 4 Extract character from template in a loop 5 Use of STRING_TO_NUM() on extracted character in a loop 6 Substring statement to pick up current group from TelNum and concatenate with FString in a loop 7 Concatenate SPACE separator in a loop 8 Concatenate final characters from TelNum after the loop (+ or – 1 characters) 9 Return the formatted string after reasonable attempt <p>Max 8 Max 7 for not fully working solutions</p>	8

Question	Answer	Marks
5(b)	<p>One mark for check plus one for corresponding test data example. Test data must be invalid to prove that the check is working.</p> <p>Telephone number:</p> <ul style="list-style-type: none">Length check // Check that the telephone number string is at least six characters e.g. number of "127" <p>OR</p> <ul style="list-style-type: none">Check it is a number // Check that the telephone number string only contains characters from '0' to '9' e.g. number of "12A" <p>Template:</p> <ul style="list-style-type: none">Check it is a number in range 1 to 5 // Check that the template string only contains characters from '1' to '5' e.g. template of "127" <p>OR</p> <ul style="list-style-type: none">Check that there are enough characters in the TelNum string so that the template can be applied e.g. Telnum = "123456", Template = "66"	4

Question	Answer	Marks
6(a)	<pre> FUNCTION CheckBackupFile() RETURNS STRING DECLARE Filename, FileLine, Response : STRING Filename ← "" WHILE Filename = "" Filename ← GetValidFilename() OPENFILE Filename FOR READ READFILE Filename, FileLine CLOSEFILE Filename IF FileLine <> "" //check if data in file THEN OUTPUT "File already exists - do you want to overwrite? " INPUT Response IF Response <> "Yes" THEN Filename ← "" OUTPUT "Please input a different filename " ENDIF ENDIF ENDWHILE RETURN Filename ENDFUNCTION </pre> <p>One mark for each of the following:</p> <ol style="list-style-type: none"> 1 Conditional loop 2 Use of GetValidFilename() in a loop 3 OPEN file in READ mode and CLOSE in a loop 4 Test if file not empty (using EOF() or READ empty string) 5 If not empty, prompt and input (in case of a non-empty file) in a loop 6 and process response 7 Set loop termination condition by checking for new file or overwrite confirmed in a loop 8 Return Filename 	8

Question	Answer	Marks
6(b)	<p>'Pseudocode' solution included here for development and clarification of mark scheme. Programming language example solutions appear in the Appendix</p> <pre> PROCEDURE GroupReport (Group : STRING) DECLARE Total : REAL DECLARE Count, Index : INTEGER Total ← 0 Count ← 0 FOR Index ← 1 TO 10000 IF LEFT (StockID[Index], 4) = Group THEN Count ← Count + 1 Total ← Total + (Quantity[Index] * Cost[Index]) ENDIF ENDFOR IF Count = 0 THEN OUTPUT "There are no items in Group: ", Group ELSE OUTPUT "Group: ", Group OUTPUT "Number of items in Group: ", Count OUTPUT "Total value of items in Group: ", Total ENDIF ENDPROCEDURE </pre> <p>1 mark for each of the following:</p> <ol style="list-style-type: none"> 1 Procedure heading and ending including input parameter 2 Declare and initialise local variables for Total and Count 3 Loop through all 10 000 elements (allow LEN(StockID)) 4 Check for required group using substring function in a loop 5 ...Increment Count and sum Total using correct array notation 6 Generate both sets of output as appropriate after loop 	6

Question	Answer	Marks
6(c)	<p>'Pseudocode' solution included here for development and clarification of mark scheme. Programming language example solutions appear in the Appendix</p> <pre> FUNCTION GroupSummary() RETURNS INTEGER DECLARE Index, GroupIndex Total : INTEGER DECLARE ThisGroup : STRING Total ← 0 FOR Index ← 1 TO 10000 IF StockID[Index] <> "" THEN ThisGroup ← LEFT(StockID[Index], 4) GroupIndex ← Lookup(ThisGroup) IF GroupIndex = -1 //ThisGroup not found THEN //add new group Summary[Total + 1] ← ThisGroup Total ← Total + 1 ENDIF ENDIF ENDFOR RETURN Total ENDFUNCTION </pre> <p>1 mark for each of the following:</p> <ol style="list-style-type: none"> 1 Function heading and ending and final return of Total 2 Declare and initialise Total 3 Loop through all 10 000 elements 4 Skip empty StockID in a loop 5 Extract ThisGroup from StockID and pass to Lookup() 6 ... if Lookup() returns -1 (following reasonable attempt at MP5) 7Store ThisGroup to Summary[Total] and increment Total 	7

Program Code Example Solutions**Question 6(b): Visual Basic**

```

Sub GroupReport(Group As String)

    Dim Total As Double
    Dim Count, Index As Integer

    Total = 0
    Count = 0

    For Index = 0 To 3 \1 to 10000
        If Left(StockID(Index), 4) = Group Then
            Count = Count + 1
            Total = Total + (Quantity(Index) * Cost(Index))
        End If
    Next Index

    If Count = 0 Then
        Console.WriteLine("There are no items in Group: " & Group)
    Else
        Console.WriteLine("Group: " & Group)
        Console.WriteLine("Number of items in Group: " & Count)
        Console.WriteLine("Total value of items in Group: " & Total)
    End If

End Sub

```

Question 6(b): Pascal

```

procedure GroupReport(Group : string);

var
    Total : real;
    Count, Index : integer;

begin
    Total := 0;
    Count := 0;

    for Index := 1 TO 10000 do
        begin
            if LeftStr(StockID[Index], 4) = Group then
                begin
                    Count := Count + 1;
                    Total := Total + (Quantity[Index] * Cost[Index]);
                end;
            end;
        end;

    if Count = 0 then
        writeln('There are no items in Group: ', Group)
    else
        begin
            writeln('Group: ', Group);
            writeln('Number of items in Group: ', Count);
            writeln('Total value of items in Group: ', Total);
        end;
    end;

end;

```

Question 6(b): Python

```
def GroupReport (Group) :

    ## Total As Real
    ## Count, Index As Integer
    ## ThisID As String

    Total = 0
    Count = 0

    for Index in range(1, 10001):
        ThisID = StockID[Index]
        if ThisID[:4] == Group:
            Count = Count + 1
            Total = Total + (Quantity[Index] * Cost[Index])

    if Count == 0:
        print("There are no items in Group: ", Group)
    else:
        print("Group: ", Group)
        print("Number of items in Group: ", Count)
        print("Total value of items in Group: ", Total)
```

Question 6(c): Visual Basic

```
Function GroupSummary() As Integer

    Dim Index, GroupIndex, Total As Integer
    Dim ThisGroup As String

    Total = 0

    For Index = 1 TO 10000
        If StockID(Index) <> "" Then
            ThisGroup = Left(StockID(Index), 4)
            GroupIndex = Lookup(ThisGroup)
            If GroupIndex = -1 Then // ThisGroup not found
                Summary(Total + 1) = ThisGroup // Add new Group
                Total = Total + 1
            End If
        End If
    Next Index

    Return Total

End Function
```

Question 6(c): Pascal

```

function GroupSummary() : Integer;

var
  Index, GroupIndex, Total : Integer;
  ThisGroup : String;

begin
  Total := 0;

  for Index := 1 TO 10000 do
  begin
    if StockID[Index] <> "" then
    begin
      ThisGroup := LeftStr(StockID[Index], 4);
      GroupIndex := Lookup(ThisGroup);
      If GroupIndex = -1 then //ThisGroup not found
      begin
        Summary[Total + 1] := ThisGroup; //Add new Group
        Total := Total + 1;
      end;
    end;
  end;

  GroupSummary := Total; // result := Total;

end;

```

Question 6(c): Python

```

def GroupSummary():

    ## Index, GroupIndex, Total As Integer
    ## ThisGroup, ThisID As String

    Total = 0

    for Index in range(1, 10001):
        ThisID = StockID[Index]
        if ThisID != "":
            ThisGroup = ThisID[:4]
            GroupIndex = Lookup(ThisGroup)
            if GroupIndex == -1: #ThisGroup not found
                Summary[Total + 1] = ThisGroup #Add new Group
                Total = Total + 1

    return Total

```