Cambridge Assessment International Education

Cambridge International AS & A Level

COMPUTER SCIENCE	**9608/43**
Paper 4 Further Problem-solving and Programming Skills	**October/November 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.

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

This document consists of **19** 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.

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>1 mark for `TopPointer`
1 mark for correct data in stack

<table>
<tr><td><b>TopPointer</b></td><td>2</td></tr>
</table>

<table>
<tr><th>Index</th><th>Data</th></tr>
<tr><td>[7]</td><td></td></tr>
<tr><td>[6]</td><td></td></tr>
<tr><td>[5]</td><td></td></tr>
<tr><td>[4]</td><td></td></tr>
<tr><td>[3]</td><td>(8)</td></tr>
<tr><td>[2]</td><td>50</td></tr>
<tr><td>[1]</td><td>20</td></tr>
<tr><td>[0]</td><td>10</td></tr>
</table>

</td><td><b>2</b></td></tr>
</table>

Question	Answer	Marks
1(b)	1 mark per bullet point • Function header (and close where appropriate returning an integer) • Checking if stack is empty … • … and returning −1 if it is • If there is data in stack, decrementing `TopPointer` • (Otherwise) returning the **top** Value	**5**

Example code:

VB.NET

```
Function Pop()
  Dim Value as Integer
  If TopPointer < 0 Then
    Return -1
  Else
    Value = DataStack(TopPointer)
    TopPointer = TopPointer - 1
    Return Value
  End if
End Function
```

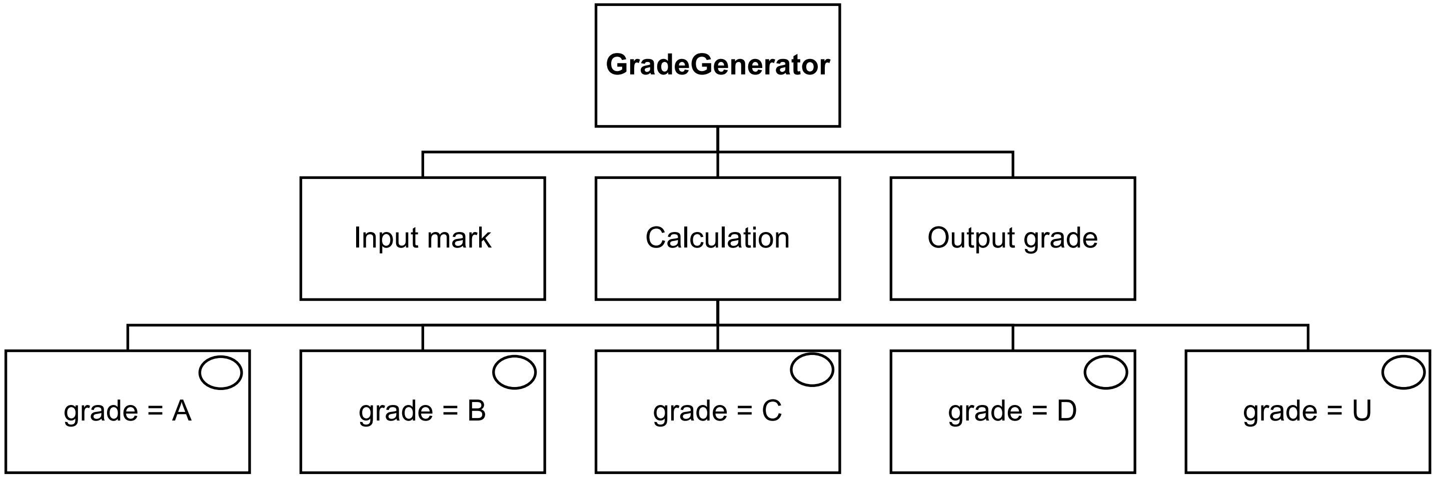
Python

```
def Pop():
  if TopPointer < 0 :
    return -1
  else:
    Value = DataStack(TopPointer)
    TopPointer= TopPointer - 1
    return Value
```

Question	Answer	Marks

1(b)	**Pascal**
	`Function Pop(): integer;`
	`var`
	`  Value : integer;`
	`begin`
	`  if TopPointer < 0 then`
	`    Pop := -1`
	`  else`
	`    Value := DataStack(TopPointer);`
	`    TopPointer := TopPointer – 1;`
	`    Pop := Value`
	`end;`	

1(c)	1 mark per bullet point to max 2 • In a stack the last item in is the first out/LIFO **and** in a queue the first item in is the first out/FIFO • Queue can be circular, but a stack is linear • Stack only needs a pointer to the top (and can have a base pointer) **and** a queue needs a pointer to the front and the rear	**2**

Question	Answer	Marks
2	1 mark per bullet point • Input **mark**, calculate grade and output **grade** on level 1… • … in correct order • All grades below calculation • Selection only on the grades and no other iteration/selection anywhere  **GradeGenerator** Input mark Calculation Output grade grade = A grade = B grade = C grade = D grade = U	**4**

Question	Answer	Marks

3	1 mark for each completed statement
	
	FUNCTION BinarySearch(ThisArray, LowerBound, UpperBound, SearchItem: INTEGER)
	                                                  RETURNS INTEGER
	  DECLARE Flag : BOOLEAN
	  DECLARE Mid : INTEGER
	  Flag ← -2
	  WHILE Flag <> -1
	    Mid ← LowerBound + ((UpperBound - LowerBound) DIV 2)
	    IF **UpperBound** < **LowerBound**
	      THEN
	        RETURN **-1**
	      ELSE
	        IF ThisArray[Mid] > SearchItem
	          THEN
	            UpperBound ← Mid **– 1**
	          ELSE
	
	            IF ThisArray[Mid] < SearchItem
	              THEN
	                 LowerBound ← Mid **+ 1**
	
	              ELSE
	                RETURN **Mid**
	             ENDIF
	         ENDIF
	      ENDIF
	  ENDWHILE
	ENDFUNCTION
		6

Question	Answer	Marks

4(a)	1 mark per clause
	teacher(fred)
	busy(fred, tuesday, 1)
		2

Question	Answer	Marks

4(b)	1 mark for 1 correct
	1 mark for all 3 days of the week correct
	`busy(jill, monday, 1)`
	`busy(jill, tuesday, 1)`
	`busy(jill, wednesday, 1)`
	
	1 mark for 1 correct
	1 for the other 2 with OR
	`busy(jill, monday, 1) OR busy(jill, tuesday, 1) OR busy(jill, wednesday, 1)`
		2

4(c)	1 mark `busy(X, monday, 3)`	**1**
4(d)	1 mark per bullet point • Checking X is a teacher • Checking Y is a timeslot, Z is a day • `NOT(busy(X, Z, Y))` • All included, linked with ANDs and nothing superfluous `teacher(X) AND timeslot(Y) AND day(Z) AND NOT(busy(X, Z, Y))`	**4**

Question	Answer	Marks
5(a)	1 mark per bullet point • Output = 21 • Function calls with Recursion(104,102) and Recursion(103, 102) • Function calls with 102 and 102, and 92 and 102 • Unwinding the return values 5+5+10+1	**4**

Function call	A	B	Return value
Recursion(104, 102)	104	102	5 + Recursion(103, 102) 5 + 16
Recursion(103, 102)	103	102	5 + Recursion(102, 102) 5 + 11
Recursion(102, 102)	102	102	10 + Recursion(92, 102) 10 + 1
Recursion(92, 102)	92	102	1

Question	Answer	Marks
5(b)	1 mark per bullet point to max 4 • Function header takes two parameters, returns the calculated value accurately (outside/end loop and in all cases) • Initialising variable to 1 outside loop (or adds 1 before returning) • Looping while A > 100 // looping until A <= 100 (or equivalent) … • … checking if A > B inside loop **and** if true, add 5 to variable and decrement A • … checking if A<= B in loop **and** if true, add 10 to variable and A – 10 Example pseudocode:	**4**

```
FUNCTION Recursion(A, B  : INTEGER) RETURNS INTEGER
  DECLARE Value : INTEGER
  Value ← 1
  WHILE A > 100
      IF A > B
        THEN
          Value ← Value + 5
           A ← A - 1
        ELSE
          Value ← Value + 10
          A ← A - 10
      ENDIF
  ENDWHILE
  RETURN Value
ENDFUNCTION
```

Question	Answer	Marks
6(a)(i)	1 mark per bullet point • Data structure to store **multiple pieces of data** (under one identifier) • ... (stores data) of that can be different data types	**2**

Question	Answer	Marks

6(a)(ii)	1 mark per bullet point
	• record declaration named `CustomerData` …
	• … all 3 correct data items with suitable data types (and identifiers)
	
	`TYPE CustomerData`
	`  DECLARE CustomerID : INTEGER`
	`  DECLARE FirstName : STRING`
	`  DECLARE SecondName : STRING`
	`ENDTYPE`
		2

6(b)	1 mark per completed statement
	
	`PROCEDURE StoreRecord(NewData : `**`CustomerData`**`)`
	`  HashValue ← CustomerHash(NewData.CustomerID)`
	`  Filename ← "CustomerRecords.dat"`
	`  OPENFILE Filename FOR `**`RANDOM`**
	`  SEEK Filename, `**`HashValue`**
	`  PUTRECORD Filename, `**`NewData`**
	`  `**`CLOSE`**` Filename`
	`ENDPROCEDURE`
		5

6(c)	1 mark for naming a feature, 1 for description. Max 2 for each feature Example: • Breakpoint • Stop the program at a set point and check the variables • Stepping/step-through etc. • Execute the program one line at a time to check the values • Variable watch window • Displays the variable values whilst the program is running so Kobi can make sure they are changed correctly	**4**

Question	Answer	Marks
6(d)	1 mark for benefit, 1 for drawback Benefit Example: • Saves time because does not have to write own code // write program faster • Programmer can have limited skills and still produce complex programs Drawback Example: • May not perform the tasks exactly as required • Solution is likely to be inefficient • Might produce errors • The programmer may not understand the solution and hence cannot edit/change	**2**

Question	Answer	Marks
7(a)	1 mark per bullet point to max 2 • To stop the program crashing … • To stop a run-time error … • … to make sure the input is the correct data type // other reasonable example	**2**

Question	Answer	Marks

7(b)	1 mark per bullet point
	• Using try (and close where appropriate) followed by the input
	• Catching exception
	• Outputting appropriate message (built-in or otherwise)
	
	Example program code:
	
	VB.NET
	`Try`
	`  Dim Value As Integer`
	`  Console.WriteLine("Enter a number")`
	`  Value = Console.ReadLine()`
	`Catch ex As Exception`
	`  Console.WriteLine(ex.Message)`
	`End Try`
	
	Python
	`try:`
	`    Value = int(input("Enter a number"))`
	`except:`
	`    print("Invalid number")`
	
	Pascal:
	`begin`
	`try`
	`  readln(Value);`
	`except`
	`  On E : Exception do writeln("Invalid number");`
	`end;`
		3

7(c)	1 mark per example • Check file exists • No input • No data in file • Array out of bounds • Calculation / division by 0	**2**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(a)</td><td>1 mark for rows with index 0, 1 and 3
1 mark for null pointers set to −1
RootNode 0
<table>
<tr><th>Index</th><th>LeftPointer</th><th>Data</th><th>RightPointer</th></tr>
<tr><td>[0]</td><td>3</td><td>50</td><td>1</td></tr>
<tr><td>[1]</td><td>6</td><td>67</td><td>2</td></tr>
<tr><td>[2]</td><td>–1</td><td>77</td><td>–1</td></tr>
<tr><td>[3]</td><td>4</td><td>35</td><td>5</td></tr>
<tr><td>[4]</td><td>–1</td><td>2</td><td>–1</td></tr>
<tr><td>[5]</td><td>–1</td><td>43</td><td>–1</td></tr>
<tr><td>[6]</td><td>–1</td><td>52</td><td>–1</td></tr>
<tr><td>[7]</td><td>–1</td><td></td><td>–1</td></tr>
<tr><td>[8]</td><td>–1</td><td></td><td>–1</td></tr>
<tr><td>[9]</td><td>–1</td><td></td><td>–1</td></tr>
<tr><td>[10]</td><td>–1</td><td></td><td>–1</td></tr>
</table>
</td><td>2</td></tr>
</table>

Question	Answer	Marks

8(b)	1 mark for each completed statement
	`PROCEDURE PostOrder(`**`RootNode`**` : INTEGER)`
	   `IF BinaryTree[RootNode, 0] <> -1 THEN`
	      `PostOrder``(BinaryTree[RootNode, `**`0`**`])`
	   `ENDIF`
	   `IF BinaryTree[RootNode, 2] <> -1 THEN`
	      `PostOrder``(BinaryTree[RootNode, 2])`
	   `ENDIF`
	   `OUTPUT(BinaryTree[RootNode, `**`1`**`])`
	`ENDPROCEDURE`
		5

Question	Answer	Marks

9(a)	1 mark per bullet point
	• array named StoredData of type integer
	• with 10 000 elements, index 0 – 9999
	• All elements initialised with −1
	
	Example pseudocode
	
	`DECLARE StoredData : ARRAY[0:9999] OF INTEGER`
	`FOR X ← 0 to 9999`
	  `StoredData[X] ← -1`
	`NEXT X`
		3

9(b)	1 mark per bullet point to max 7	**7**

Question	Answer	Marks
9(b)	• Function declaration (and end where appropriate) taking data as (integer) parameter (returns Boolean) • Calculate hash: **parameter** mod 1000 + 6 • Check if StoredData[hashed value] = –1 … • … if it is –1, store data at **hash** … • … and return true • … if not –1, increment/decrement hashed value by 1 … • … if reached index 9999 return to index 0 // checking and going to 9999 if not at 0 • … repeatedly decrement until either **found or all elements checked** … • … returning False if **full and** True when stored	

Example program code

VB.NET

```
Function AddItem(DataToAdd)
  Dim Location As Integer
  Dim Found As Boolean
  Dim Counter As Integer

  Location = (DataToAdd Mod 1000) + 6
  If StoredData(Location) <> -1 Then
    Found = False
    Counter = 0
    While Found = False And Counter < 9999
      Location = Location + 1
      If Location > 9999 Then
        Location = 0
      End If
      If StoredData(Location) = -1 Then
        Found = True
      End If
      Counter = Counter + 1
    End While
```

Question	Answer	Marks
9(b)		

```
    If Found = True Then
      StoredData(Location) = DataToAdd
      Return True
    Else
      Return False
    End If
  Else
    StoredData(Location) = DataToAdd
    Return True
  End If
End Function
```

Python

```
def AddItem(DataToAdd):
    Location = (DataToAdd % 1000) + 6
    if StoredData[Location] <> -1:
        Found = False
        Counter = 0

        while Found == False and Counter < 9999:
            Location = Location + 1
            if Location > 9999:
               Location = 0
            if StoredData[Location] == -1:
                Found = True
                Counter = Counter + 1

            if Found == True:
                StoredData[Location] = DataToAdd
                return True
            else:
                return False
    else:
        StoredData[Location] = DataToAdd
        return True
```

Question	Answer	Marks
9(b)	**Pascal**	

```
function AddItem(DataToAdd:Integer):Boolean;
begin
   Location := (DataToAdd mod 1000) + 6;
   if StoredData[Location] <> -1 then
       begin
          Found := false;
          Counter := 0;

          while (Found = false) and (Counter < 9999) do
             begin
                Location := Location + 1;
                if Location > 9999 then
                   Location := 0;
                if StoredData[Location] = -1 then
                   found := true;
                Counter := Counter + 1;
             end;
             if Found = true then
                begin
                   StoredData[Location] := DataToAdd;
                   AddItem := True;
                end
             Else
                begin
                   AddItem := False;
                end;
      end
   else
      begin
         StoredData[Location] := DataToAdd;
         AddItem := True;
      end;
end;
```