

Cambridge
International
AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

COMPUTER SCIENCE

9608/42

Paper 4 Written Paper

May/June 2017

MARK SCHEME

Maximum Mark: 75

Published

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This document consists of **19** printed pages.

Question	Answer				Marks																																																								
1(a)	<table border="1"> <thead> <tr> <th>Label</th> <th>Op code</th> <th>Operand</th> <th>Comment</th> </tr> </thead> <tbody> <tr> <td>START:</td> <td>IN</td> <td></td> <td>// INPUT character</td> </tr> <tr> <td></td> <td>STO</td> <td>CHAR1</td> <td>// store in CHAR1</td> </tr> <tr> <td></td> <td>IN</td> <td></td> <td>// INPUT character</td> </tr> <tr> <td></td> <td>STO</td> <td>CHAR2</td> <td>// store in CHAR2</td> </tr> <tr> <td></td> <td>LDD</td> <td>CHAR1</td> <td>// initialise ACC to ASCII value of CHAR1</td> </tr> <tr> <td>LOOP:</td> <td>OUT</td> <td></td> <td>//output contents of ACC</td> </tr> <tr> <td></td> <td>CMP</td> <td>CHAR2</td> <td>// compare ACC with CHAR2</td> </tr> <tr> <td></td> <td>JPE</td> <td>ENDFOR</td> <td>// if equal jump to end of FOR loop</td> </tr> <tr> <td></td> <td>INC</td> <td>ACC</td> <td>// increment ACC</td> </tr> <tr> <td></td> <td>JMP</td> <td>LOOP</td> <td>// jump to LOOP</td> </tr> <tr> <td>ENDFOR:</td> <td>END</td> <td></td> <td></td> </tr> <tr> <td>CHAR1:</td> <td></td> <td></td> <td></td> </tr> <tr> <td>CHAR2:</td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Label	Op code	Operand	Comment	START:	IN		// INPUT character		STO	CHAR1	// store in CHAR1		IN		// INPUT character		STO	CHAR2	// store in CHAR2		LDD	CHAR1	// initialise ACC to ASCII value of CHAR1	LOOP:	OUT		//output contents of ACC		CMP	CHAR2	// compare ACC with CHAR2		JPE	ENDFOR	// if equal jump to end of FOR loop		INC	ACC	// increment ACC		JMP	LOOP	// jump to LOOP	ENDFOR:	END			CHAR1:				CHAR2:						<div style="text-align: right;"> } 1 } 1 1 1+1 1 1 1 1 1 1 1 1 1 1 </div>	9
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2(a)	<ul style="list-style-type: none"> A pointer that doesn't point to another node/other data/address // indicates the end of the branch 	1																																																							
2(b)	one mark per bullet <ul style="list-style-type: none"> node with 'Athens' linked to left pointer of Berlin (ignore null pointer) null pointers in left and right pointers of Athens 	2																																																							
2(c)(i)	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center; border: none;">RootPointer</th> <th style="border: none;"></th> <th style="text-align: center; border: none;">LeftPointer</th> <th style="text-align: center; border: none;">Tree Data</th> <th style="text-align: center; border: none;">RightPointer</th> </tr> </thead> <tbody> <tr> <td style="text-align: center; border: 1px solid black; width: 100px;">0</td> <td style="border: none; padding: 0 10px;">[0]</td> <td style="text-align: center; border: 1px solid black; width: 100px;">2</td> <td style="text-align: center; border: 1px solid black; width: 150px;">Dublin</td> <td style="text-align: center; border: 1px solid black; width: 100px;">1</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; padding: 0 10px;">[1]</td> <td style="text-align: center; border: 1px solid black;">-1/∅</td> <td style="text-align: center; border: 1px solid black;">London</td> <td style="text-align: center; border: 1px solid black;">3</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; padding: 0 10px;">[2]</td> <td style="text-align: center; border: 1px solid black;">6</td> <td style="text-align: center; border: 1px solid black;">Berlin</td> <td style="text-align: center; border: 1px solid black;">5</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; padding: 0 10px;">[3]</td> <td style="text-align: center; border: 1px solid black;">4</td> <td style="text-align: center; border: 1px solid black;">Paris</td> <td style="text-align: center; border: 1px solid black;">-1/∅</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; padding: 0 10px;">[4]</td> <td style="text-align: center; border: 1px solid black;">-1/∅</td> <td style="text-align: center; border: 1px solid black;">Madrid</td> <td style="text-align: center; border: 1px solid black;">-1/∅</td> </tr> <tr> <td style="text-align: center; border: none;">FreePointer</td> <td style="border: none; padding: 0 10px;">[5]</td> <td style="text-align: center; border: 1px solid black;">-1/∅</td> <td style="text-align: center; border: 1px solid black;">Copenhagen</td> <td style="text-align: center; border: 1px solid black;">-1/∅</td> </tr> <tr> <td style="text-align: center; border: none;">7</td> <td style="border: none; padding: 0 10px;">[6]</td> <td style="text-align: center; border: 1px solid black;">-1/∅</td> <td style="text-align: center; border: 1px solid black;">Athens</td> <td style="text-align: center; border: 1px solid black;">-1/∅</td> </tr> <tr> <td style="text-align: center; border: none;">1 mark</td> <td style="border: none; padding: 0 10px;">[7]</td> <td style="text-align: center; border: 1px solid black;">8</td> <td style="text-align: center; border: 1px solid black;"></td> <td style="text-align: center; border: 1px solid black;">-1/∅</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; padding: 0 10px;">[8]</td> <td style="text-align: center; border: 1px solid black;">9</td> <td style="text-align: center; border: 1px solid black;"></td> <td style="text-align: center; border: 1px solid black;">-1/∅</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; padding: 0 10px;">[9]</td> <td style="text-align: center; border: 1px solid black;">-1/∅</td> <td style="text-align: center; border: 1px solid black;"></td> <td style="text-align: center; border: 1px solid black;">-1/∅</td> </tr> </tbody> </table>	RootPointer		LeftPointer	Tree Data	RightPointer	0	[0]	2	Dublin	1		[1]	-1/∅	London	3		[2]	6	Berlin	5		[3]	4	Paris	-1/∅		[4]	-1/∅	Madrid	-1/∅	FreePointer	[5]	-1/∅	Copenhagen	-1/∅	7	[6]	-1/∅	Athens	-1/∅	1 mark	[7]	8		-1/∅		[8]	9		-1/∅		[9]	-1/∅		-1/∅	5
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2(c)(ii)	<ul style="list-style-type: none"> -1 It is not the number for any node. 	2																																																							

Question	Answer	Marks
2(d)(i)	<pre> TYPE Node LeftPointer : INTEGER RightPointer : INTEGER Data : STRING ENDTYPE DECLARE Tree : ARRAY[0 : 9] OF Node DECLARE FreePointer : INTEGER DECLARE RootPointer : INTEGER PROCEDURE CreateTree() DECLARE Index : INTEGER RootPointer ← -1 FreePointer ← 0 FOR Index ← 0 TO 9 // link nodes Tree[Index].LeftPointer ← Index + 1 Tree[Index].RightPointer ← -1 ENDFOR Tree[9].LeftPointer ← -1 ENDPROCEDURE </pre>	<p style="text-align: right;">7</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p>

Question	Answer	Marks
2(d)(ii)	<pre> PROCEDURE AddToTree (ByVal NewDataItem : STRING) // if no free node report an error IF FreePointer = -1 THEN ERROR("No free space left") ELSE // add new data item to first node in the free list NewNodePointer ← FreePointer Tree [NewNodePointer] .Data ← NewDataItem // adjust free pointer FreePointer ← Tree [FreePointer] .LeftPointer // clear left pointer Tree [NewNodePointer] .LeftPointer ← -1 // is tree currently empty ? IF RootPointer = -1 THEN // make new node the root node RootPointer ← NewNodePointer ELSE // find position where new node is to be added Index ← RootPointer CALL FindInsertionPoint (NewDataItem, Index, Direction) </pre>	<p style="text-align: right;">8</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p>

Question	Answer	Marks
	<pre> IF Direction = "Left" THEN // add new node on left Tree[Index].LeftPointer ← NewNodePointer ELSE // add new node on right Tree[Index].RightPointer ← NewNodePointer ENDIF ENDIF ENDIF ENDPROCEDURE </pre>	<p style="text-align: right;">1</p> <p style="text-align: right;">1</p>
2(e)	<p>1 mark per bullet</p> <ul style="list-style-type: none"> • test for base case (null/-1) • recursive call for left pointer • output data • recursive call for right pointer • order, visit left, output, visit right <pre> IF Pointer <> NULL THEN TraverseTree(Tree[Pointer].LeftPointer) OUTPUT Tree[Pointer].Data TraverseTree(Tree[Pointer].RightPointer) ENDIF ENDPROCEDURE </pre>	<p style="text-align: right;">5</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1 + 1</p> <p style="text-align: right;">1</p>

Question	Answer	Marks
3(a)	<p>1 mark per bullet</p> <ul style="list-style-type: none"> • Instantiation of island object and calling DisplayGrid • Loop 3 times and Island.HideTreasure • Call procedures StartDig and DisplayGrid <p>Example Python</p> <pre> Island = IslandClass() DisplayGrid() for Treasure in range(3): Island.HideTreasure() StartDig() DisplayGrid() </pre> <p>Example Pascal</p> <pre> var Island : IslandClass; var Treasure : integer; begin Island := IslandClass.Create(); DisplayGrid; for Treasure := 1 to 3 do Island.HideTreasure(); StartDig; DisplayGrid; end; </pre>	<p>3</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>

Question	Answer	Marks
	<p>Example VB.NET</p> <pre> Dim Island As New IslandClass() DisplayGrid() For Treasure = 1 To 3 Island.HideTreasure() Next StartDig() DisplayGrid() </pre> <p>Handwritten curly braces in the code indicate marking points: one for the class declaration, one for the loop body, and one for the final display grid call.</p>	<p>1</p> <p>1</p> <p>1</p>

Question	Answer	Marks
3(b)	<p>1 mark per bullet to max 5</p> <ul style="list-style-type: none"> • Class heading and ending (in appropriate place) • Constructor heading and ending (in appropriate place) • Declaring grid with correct dimensions (as private) • Declaring Sand as a constant • Nested loops covering dimensions (0 – 29 and 0 – 9) • Assigning Sand // '.' to each array element <p>Example Python</p> <pre>class IslandClass: def __init__(self): Sand = '.' self.__Grid = [[Sand for j in range(30)] for i in range(10)]</pre> <p>Example Pascal</p> <pre>type IslandClass = class private Grid : array[0..9, 0..29] of char; public constructor Create(); procedure HideTreasure(); procedure DigHole(x, y : integer); function GetSquare(x, y : integer) : char; end; constructor IslandClass.Create(); const Sand = '.'; var i, j : integer; begin for i := 0 to 9 do for j := 0 to 29 do Grid[i, j] := Sand; end;</pre>	<p style="text-align: right;">5</p> <p style="text-align: right;">1 1 1 1 + 1 1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p>

Question	Answer	Marks
	<p>Example VB.NET</p> <pre> Class IslandClass Private Grid (9, 29) As Char Public Sub New() Const Sand = "." For i = 0 To 9 For j = 0 To 29 Grid(i, j) = Sand Next Next End Sub End Class </pre>	<p>1 1 1 1 1 1</p>
3(c)(i)	<p>1 mark per bullet</p> <ul style="list-style-type: none"> • Method (getter or property) heading, takes two parameters returns char, and ending • Method returns Grid value <p>Example Python</p> <pre> def GetSquare(self, Row, Column) : return self.__Grid[Row][Column] </pre> <p>Example Pascal</p> <pre> function IslandClass.GetSquare(Row, Column : integer) As Char; begin Result := Grid[Row, Column]; end; </pre> <p>Example VB.NET</p> <pre> Public Function GetSquare(Row As Integer, Column As Integer) As Char Return Grid(Row, Column) end Function </pre>	<p>2</p> <p>1 1 1 1 1</p>

Question	Answer	Marks
	<p>Example VB.NET</p> <pre> Public Sub HideTreasure() Const Treasure = "T" Dim RandomNumber As New Random Dim x, y As Integer Do x = RandomNumber.Next(0, 10) y = RandomNumber.Next(0, 30) Loop Until Grid(x, y) <> Treasure Grid(x, y) = Treasure End Sub </pre>	<p>1</p> <p>1</p> <p>1</p> <p>1+1</p> <p>1</p>

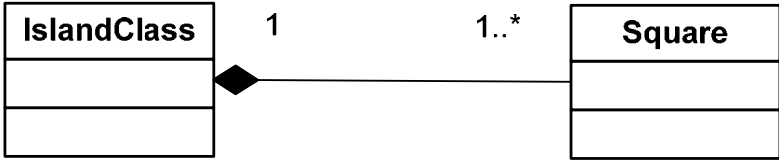
Question	Answer	Marks
3(e)(i)	<p>1 mark per bullet</p> <ul style="list-style-type: none"> • Method heading, with two parameters & Declaring constants for Treasure, Hole and FoundTreasure • Check if treasure at parameter locations • Set to FoundTreasure (X) and Set to Hole (O) <p>Example Python</p> <pre> def DigHole(self, x, y) : Treasure = 'T' Hole = 'O' Foundtreasure = 'X' if self.__Grid[x][y] == Treasure: self.__Grid[x][y] = Foundtreasure else : self.__Grid[x][y] = Hole return </pre> <p>Example Pascal</p> <pre> procedure IslandClass.DigHole(x, y : integer); const Treasure = 'T'; const Hole = 'O'; const Foundtreasure = 'X'; begin if Grid[x, y] = Treasure then Grid[x, y] := Foundtreasure else Grid[x, y] := Hole; end; </pre>	<p>3</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>

Question	Answer	Marks
	<p>Example VB.NET</p> <pre> Public Sub DigHole(x As Integer, y As Integer) Const Treasure = "T" Const Hole = "O" Const Foundtreasure = "X" If Grid(x, y) = Treasure Then Grid(x, y) = Foundtreasure Else Grid(x, y) = Hole End If End Sub </pre> <p>Handwritten annotations: A right-facing curly bracket groups the three 'Const' lines. A left-facing curly bracket groups the 'If' and 'Else' blocks. A right-facing curly bracket groups the 'End If' line.</p>	<p>1</p> <p>1</p> <p>1</p>

Question	Answer	Marks
3(e)(ii)	<p>1 mark per bullet to max 5</p> <ul style="list-style-type: none"> • Prompt to user for position down and across, read positions input as an IntegerValidation for position row – between 0 and 9 • Validation for position column- between 0 and 29 • Exception handling/pass for validation • Ask for repeated input until valid (for both row and column) • Call Island.DigHole method with the coordinates <p>Example Python</p> <pre> def StartDig() : Valid = False while not Valid : # validate down position try: x = int(input("position down <0 to 9> ? ")) if x >= 0 and x <= 9 : Valid = True except: Valid = False Valid = False while not Valid : # validate across position try : y = int(input("position across <0 to 29> ? ")) if y >= 0 and y <= 29 : Valid = True except : Valid = False island.DigHole(x, y) return </pre>	<p>Max 5</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>

Question	Answer	Marks
	<pre> Example Pascal procedure StartDig; var xString, yString : String; x, y : integer; begin Valid := False; repeat Write('position down <0 to 9>? '); ReadLn(xString); try x := StrToInt(xString); if (x >= 0) AND (x <= 9) then Valid := True; except Valid := False; until Valid; Valid := False; repeat Write(position across <0 to 29> ? '); ReadLn(yString); try y := StrToInt(yString); if (y >= 0) AND (y <= 29) then Valid := True; except Valid := False; until Valid; island.DigHole(x,y); end; </pre>	<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>

Question	Answer	Marks
	<p>Example VB.NET</p> <pre> Sub StartDig() Dim x, y As Integer Dim Valid = False Do Console.WriteLine("Position down <0 to 9>? ") Try x = CInt(Console.ReadLine()) If (x >= 0) AND (x <= 9) Then Valid = True End If Catch Valid = False 'accept different types of exceptions End Try Loop Until Valid Valid = False Do Console.WriteLine("Position across <0 to 29> ? ") Try y = int(Console.ReadLine()) If (y >= 0) AND (y <= 29) Then Valid = True End IF Catch Valid = False End Try Loop until Valid island.DigHole(x, y) End Sub </pre>	<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>
3(f)(i)	containment/aggregation	1

Question	Answer	Marks
3(f)(ii)	<ul style="list-style-type: none"> IslandClass box and Square Box, with correct connection One at IslandClass and one .. * at Square <div style="text-align: center; margin-top: 20px;">  <pre> classDiagram class IslandClass class Square IslandClass "1" *-- "1..*" Square </pre> </div>	Max 2