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

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 will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2017 series for most Cambridge IGCSE®, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

® IGCSE is a registered trademark.

© UCLES 2017

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><th>Label</th><th>Op code</th><th>Operand</th><th>Comment</th></tr>
<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 colspan="2"></td><td></td></tr>
<tr><td>CHAR2:</td><td colspan="2"></td><td></td></tr>
</table>
1
1
1
1+1
1
1
1
</td><td>9</td></tr>
<tr><td>1(b)</td><td>
<table>
<tr><th>Label</th><th>Op code</th><th>Operand</th><th>Comment</th></tr>
<tr><td>START:</td><td>LDD</td><td>NUMBER1</td><td></td></tr>
<tr><td></td><td>XOR</td><td>MASK</td><td>// convert to one's complement</td></tr>
<tr><td></td><td>INC</td><td>ACC</td><td>// convert to two's complement</td></tr>
<tr><td></td><td>STO</td><td>NUMBER2</td><td></td></tr>
<tr><td></td><td>END</td><td></td><td></td></tr>
<tr><td>MASK:</td><td colspan="2">B11111111</td><td>// show value of mask in binary here</td></tr>
<tr><td>NUMBER1:</td><td colspan="2">B00000101</td><td>// positive integer</td></tr>
<tr><td>NUMBER2:</td><td colspan="2">B11111011</td><td>// show value of negative equivalent</td></tr>
</table>
1
1
1
1
1
1
</td><td>6</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>2(a)</td><td>• A pointer that doesn't point to another node/other data/address // indicates the end of the branch</td><td>1</td></tr>
<tr><td>2(b)</td><td>one mark per bullet
• node with 'Athens' linked to left pointer of Berlin (ignore null pointer)
• null pointers in left and right pointers of Athens</td><td>2</td></tr>
<tr><td>2(c)(i)</td><td>
RootPointer
0

FreePointer
7
1 mark
<table>
<tr><th></th><th>LeftPointer</th><th>Tree Data</th><th>RightPointer</th></tr>
<tr><td>[0]</td><td>2</td><td>Dublin</td><td>1</td></tr>
<tr><td>[1]</td><td>-1/∅</td><td>London</td><td>3</td></tr>
<tr><td>[2]</td><td>6</td><td>Berlin</td><td>5</td></tr>
<tr><td>[3]</td><td>4</td><td>Paris</td><td>-1/∅</td></tr>
<tr><td>[4]</td><td>-1/∅</td><td>Madrid</td><td>-1/∅</td></tr>
<tr><td>[5]</td><td>-1/∅</td><td>Copenhagen</td><td>-1/∅</td></tr>
<tr><td>[6]</td><td>-1/∅</td><td>Athens</td><td>-1/∅</td></tr>
<tr><td>[7]</td><td>8</td><td></td><td>-1/∅</td></tr>
<tr><td>[8]</td><td>9</td><td></td><td>-1/∅</td></tr>
<tr><td>[9]</td><td>-1/∅</td><td></td><td>-1/∅</td></tr>
</table>
</td><td>5</td></tr>
<tr><td>2(c)(ii)</td><td>• –1
• It is not the number for any node.</td><td>2</td></tr>
</table>

Question	Answer	Marks
2(d)(i)	TYPE Node **LeftPointer : INTEGER** **RightPointer : INTEGER** 1 **Data : STRING** ENDTYPE DECLARE Tree : ARRAY[0 : 9] **OF Node** 1 DECLARE FreePointer : INTEGER DECLARE RootPointer : INTEGER PROCEDURE CreateTree() DECLARE Index : INTEGER **RootPointer ← -1** 1 **FreePointer ← 0** 1 FOR Index ← 0 TO 9 // link nodes **Tree[Index].LeftPointer ← Index + 1** 1 **Tree[Index].RightPointer ← -1** 1 ENDFOR **Tree[9].LeftPointer ← -1** 1 ENDPROCEDURE	**7**

Question	Answer	Marks

2(d)(ii)	PROCEDURE AddToTree(ByVal NewDataItem : STRING)
	// if no free node report an error
	IF FreePointer **= -1** 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 1
	// adjust free pointer
	FreePointer ← **Tree[FreePointer].LeftPointer** 1
	// clear left pointer
	Tree[NewNodePointer].LeftPointer ← **-1** 1
	// is tree currently empty ?
	IF **RootPointer = -1** 1
	THEN // make new node the root node
	RootPointer ← NewNodePointer 1
	ELSE // find position where new node is to be added
	Index ← RootPointer
	CALL FindInsertionPoint(NewDataItem, Index, Direction)
		8

Question	Answer	Marks
	IF Direction = "Left" THEN // add new node on left **Tree[Index].LeftPointer ← NewNodePointer** 1 ELSE // add new node on right **Tree[Index].RightPointer ← NewNodePointer** **1** ENDIF ENDIF ENDIF ENDPROCEDURE	
2(e)	**1 mark per bullet** • test for base case (null/-1) • recursive call for left pointer • output data • recursive call for right pointer • order, visit left, output, visit right IF Pointer <> NULL 1 THEN TraverseTree(Tree[Pointer].LeftPointer) 1 OUTPUT Tree[Pointer].Data 1 + 1 TraverseTree(Tree[Pointer].RightPointer) 1 ENDIF ENDPROCEDURE	**5**

Question	Answer	Marks

3(a)	**1 mark per bullet**
	• Instantiation of island object and calling DisplayGrid
	• Loop 3 times and Island.HideTreasure
	• Call procedures StartDig and DisplayGrid
	
	Example Python
	`Island = IslandClass()` 1
	`DisplayGrid()`
	`for Treasure in range(3):`
	`  Island.HideTreasure()` 1
	`StartDig()`
	`DisplayGrid()` 1
	
	Example Pascal
	`var Island : IslandClass;`
	`var Treasure : integer;`
	`begin`
	`  Island := IslandClass.Create();` 1
	`  DisplayGrid;`
	`  for Treasure := 1 to 3 do`
	`  Island.HideTreasure();` 1
	`  StartDig;`
	`  DisplayGrid;` 1
	`end;`
		3

Question	Answer	Marks

	Example VB.NET
	`Dim Island As New IslandClass()`
	`DisplayGrid()` — 1
	`For Treasure = 1 To 3`
	`  Island.HideTreasure()` — 1
	`Next`
	`StartDig()`
	`DisplayGrid()` — 1	

Question	Answer	Marks

3(b)	**1 mark per bullet to max 5**
	• 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
	
	Example Python
	`class IslandClass:` 1
	`  def __init__(self):` 1
	`  Sand = '.'` 1
	`  self.__Grid = [[Sand for j in range(30)]` 1 + 1
	`  for i in range(10)]` 1
	
	Example Pascal
	`type`
	`IslandClass = class` 1
	`private`
	`  Grid : array[0..9, 0..29] of char;` 1
	`public`
	`  constructor Create();`
	`  procedure HideTreasure();`
	`  procedure DigHole(x, y : integer);`
	`  function GetSquare(x, y : integer) : char;`
	`end;`
	`constructor IslandClass.Create();` 1
	`  const Sand = '.';` 1
	`  var i, j : integer;`
	`  begin`
	`  for i := 0 to 9 do`
	`  for j := 0 to 29 do` 1
	`  Grid[i, j] := Sand;` 1
	`  end;`
		5

Question	Answer	Marks

	Example VB.NET
	`Class IslandClass` 1
	`  Private Grid (9, 29) As Char` 1
	`  Public Sub New()` 1
	`  Const Sand = "."` 1
	`  For i = 0 To 9`
	`  For j = 0 To 29` 1
	`  Grid(i, j) = Sand` 1
	`  Next`
	`  Next`
	`  End Sub`
	`End Class`	

3(c)(i)	**1 mark per bullet**
	• Method (getter or property) heading, takes two parameters returns char, and ending
	• Method returns Grid value
	
	Example Python
	`def GetSquare(self, Row, Column) :` 1
	`  return self.__Grid[Row][Column]` 1
	
	Example Pascal
	`function IslandClass.GetSquare( Row, Column : integer) As Char;` 1
	`begin`
	`  Result := Grid[Row, Column];`
	`end;` 1
	
	Example VB.NET
	`Public Function GetSquare(Row As Integer, Column As Integer) As Char` 1
	`  Return Grid(Row, Column)` 1
	`end Function`
		2

Question	Answer	Marks

3(c)(ii)	1 mark per bullet
	• DisplayGrid header and ending, with two loops with correct limits
	• Calling **Island.**GetSquare with correct parameters inside iteration
	• Output an entire row in one line
	• Output a new line at the end of a row
	
	Example Python
	`def DisplayGrid() :`
	`  for i in range (10) :`
	`  for j in range (30) :` 1
	`  print(island.GetSquare(i, j), end='')` 1 + 1
	`  print()` 1
	
	Example Pascal
	`procedure DisplayGrid():`
	`var i, j : integer;`
	`begin`
	`  for i := 0 to 9 do`
	`  begin`
	`  for j := 0 to 29 do` 1
	`  write(island.GetSquare(i, j)));` 1 + 1
	`  writeLn;` 1
	`  end;`
	`end;`
	
	Example VB.NET
	`Sub DisplayGrid()`
	`  For i = 0 to 9`
	`  For j = 0 to 29` 1
	`  Console.Write(island.GetSquare(i, j))` 1 + 1
	`  Next`
	`  Console.WriteLine()` 1
	`  Next`
	`End Sub`
		4

Question	Answer	Marks

3(d)	**1 mark per bullet to max 5**
	• Method header and Declaring Treasure as a constant
	• Generating a random number for column
	• Generating a random number for row
	• Check whether treasure already at <u>generated</u> location
	• Repeatedly generate new coordinates in a loop
	• Assign Treasure to location
	
	Example Python
	`def HideTreasure(self):` 1
	`  Treasure = 'T'`
	`  x = randint(0,9)` 1
	`  y = randint(0,29)` 1
	`  while self.__Grid[y][x] == Treasure:` 1+1
	`  x = randint(0,9)`
	`  y = randint(0,29)`
	`  self.__Grid[y][x] = Treasure` 1
	
	Example Pascal
	`procedure IslandClass.HideTreasure();`
	`  const Treasure = 'T';` 1
	`  var x, y : integer;`
	`  begin`
	`  repeat`
	`  x := Random(10);` 1
	`  y := random(30);` 1
	`  until Grid[x, y] <> Treasure;` 1+1
	`  Grid[x, y] := Treasure;` 1
	`  end;`
		Max 5

Question	Answer	Marks

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

Question	Answer	Marks

3(e)(i)	**1 mark per bullet**
	• 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)
	
	Example Python
	`def DigHole(self, x, y) :`
	`  Treasure = 'T'`
	`  Hole = 'O'` 1
	`  Foundtreasure = 'X'`
	`  if self.__Grid[x][y] == Treasure:` 1
	`  self.__Grid[x][y] = Foundtreasure`
	`  else :` 1
	`  self.__Grid[x][y] = Hole`
	`  return`
	
	Example Pascal
	`procedure IslandClass.DigHole(x, y : integer);`
	`  const Treasure = 'T';`
	`  const Hole = 'O';`
	`  const Foundtreasure = 'X';` 1
	`  begin`
	`  if Grid[x, y] = Treasure` 1
	`  then`
	`  Grid[x, y] := Foundtreasure`
	`  else`
	`  Grid[x, y] := Hole;` 1
	`  end;`
		3

Question	Answer	Marks

	Example VB.NET
	`Public Sub DigHole(x As Integer, y As Integer)`
	`  Const Treasure = "T"`
	`  Const Hole = "O"`
	`  Const Foundtreasure = "X"` 1
	`  If Grid(x, y) = Treasure Then` 1
	`  Grid(x, y) = Foundtreasure`
	`  Else`
	`  Grid(x, y) = Hole` 1
	`  End If`
	`End Sub`	

Question	Answer	Marks

3(e)(ii)	**1 mark per bullet to max 5**
	• 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
	
	Example Python
	`def StartDig() :`
	`  Valid = False`
	`  while not Valid :  # validate down position` 1
	`  try:`
	`  x = int(input("position down <0 to 9> ? "))` 1
	`  if x >= 0 and x <= 9 :` 1
	`  Valid = True`
	`  except:`
	`  Valid = False`
	`  Valid = False`
	`  while not Valid :  # validate across position`
	`  try :`
	`  y = int(input("position across <0 to 29> ? "))` 1
	`  if y >= 0 and y <= 29 :` 1
	`  Valid = True`
	`  except :`
	`  Valid = False`
	`  island.DigHole(x, y)` 1
	`  return`
		Max 5

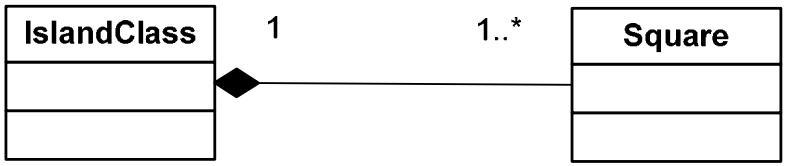
Question	Answer	Marks
	Example Pascal	

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

Question	Answer	Marks

	Example VB.NET
	`Sub StartDig()`
	`  Dim x, y As Integer`
	`  Dim Valid = False`
	`  Do`
	`  Console.Write("Position down <0 to 9>? ")`
	`  Try`
	`  x = CInt(Console.ReadLine())` 1
	`  If (x >= 0) AND (x <= 9) Then` 1
	`  Valid = True`
	`  End If`
	`  Catch`
	`  Valid = False 'accept different types of exceptions`
	`  End Try`
	`  Loop Until Valid`
	`Valid = False`
	`  Do`
	`  Console.Write("Position across <0 to 29> ? ")`
	`  Try`
	`  y = int(Console.ReadLine())` 1
	`  If (y >= 0) AND (y <= 29) Then` 1
	`  Valid = True`
	`  End IF`
	`  Catch`
	`  Valid = False`
	`  End Try`
	`  Loop until Valid` 1
	`  island.DigHole(x, y)` 1
	`End Sub`	

3(f)(i)	containment/aggregation	**1**

Question	Answer	Marks
3(f)(ii)	• IslandClass box and Square Box, with correct connection • One at IslandClass and one .. * at Square 	**Max 2**