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AS & A Level

**Cambridge Assessment International Education**  
Cambridge International Advanced Subsidiary and Advanced Level

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**COMPUTER SCIENCE**

Paper 4 Further Problem-solving and Programming Skills

**9608/41**

**May/June 2019**

**2 hours**

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

**READ THESE INSTRUCTIONS FIRST**

Write your centre number, candidate number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, glue or correction fluid.

**DO NOT WRITE IN ANY BARCODES.**

Answer **all** questions.

No marks will be awarded for using brand names of software packages or hardware.

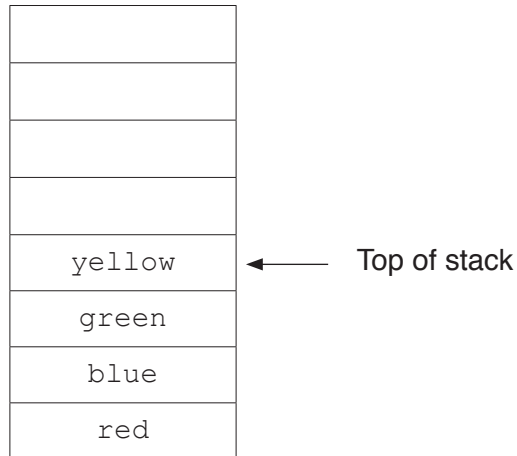
At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **18** printed pages and **2** blank pages.

- 1 (a) A stack contains the values 'red', 'blue', 'green' and 'yellow'.



- (i) Show the contents of the stack in **part(a)** after the following operations.

POP ()

PUSH ('purple')

PUSH ('orange')



[1]

(ii) Show the contents of the stack from **part(a)(i)** after these further operations.

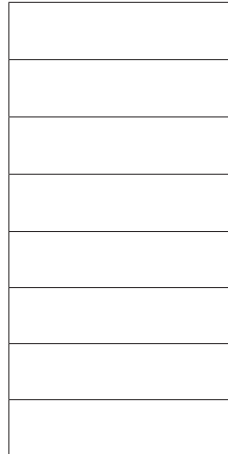
POP ()

POP ()

PUSH ('brown')

POP ()

PUSH ('black')



[1]

(b) A queue is an alternative Abstract Data Type (ADT).

Describe a **queue**.

.....

.....

.....

.....

.....

.....

.....

..... [3]

- 2 A computer games club wants to run a competition. The club needs a system to store the scores achieved in the competition.

A selection of score data is as follows:

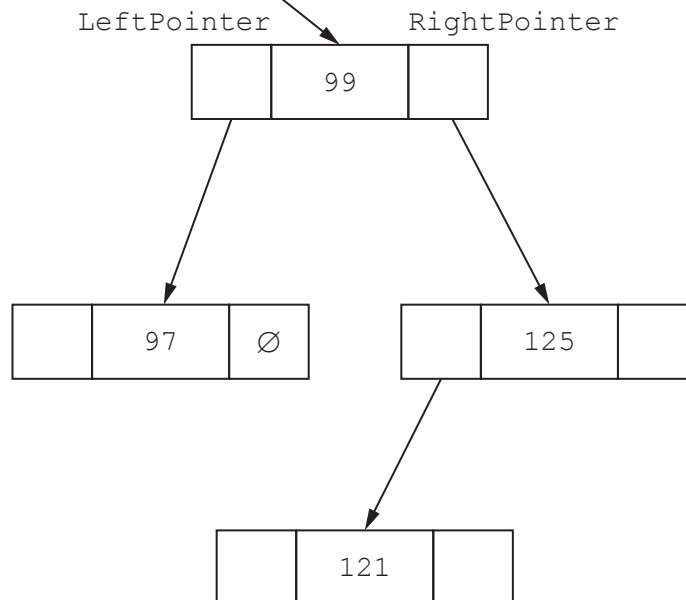
99, 125, 121, 97, 109, 95, 135, 149

- (a) A linked list of nodes will be used to store the data. Each node consists of the data, a left pointer and a right pointer. The linked list will be organised as a binary tree.
- (i) Complete the binary tree to show how the score data above will be organised.

RootPointer



The symbol  $\emptyset$  represents a null pointer.



- (ii) The following diagram shows a 2D array that stores the nodes of the binary tree's linked list.

Add the correct pointer values to complete the diagram, using your answer from part (a)(i).

**RootPointer**

**FreePointer**

Index	LeftPointer	Data	RightPointer
0		99	
1		125	
2		121	
3		97	
4		109	
5		95	
6		135	
7		149	
8			

[6]

- (b) The club also considers storing the data in the order in which it receives the scores as a linked list in a 1D array of records.

The following pseudocode algorithm searches for an element in the linked list.

Complete the **six** missing sections in the algorithm.

```

FUNCTION FindElement (Item : INTEGER) RETURNS .....
    ..... ← RootPointer

    WHILE CurrentPointer ..... NullPointer
        IF List[CurrentPointer].Data <> .....
            THEN
                CurrentPointer ← List[.....].Pointer
            ELSE
                RETURN CurrentPointer
            ENDIF
        ENDWHILE

        CurrentPointer ← NullPointer
        ..... CurrentPointer

    ENDFUNCTION

```

[6]

- (c) The games club is looking at two programming paradigms: imperative and object-oriented programming paradigms.

Describe what is meant by the **imperative programming paradigm** and the **object-oriented programming paradigm**.

(i) Imperative .....  
.....  
.....  
.....  
.....  
..... [3]

(ii) Object-oriented .....  
.....  
.....  
.....  
..... [3]

- (d) Players complete one game to place them into a category for the competition. The games club wants to implement a program to place players into the correct category. The programmer has decided to use object-oriented programming (OOP).

The highest score that can be achieved in the game is 150. Any score less than 50 will not qualify for the competition. Players will be placed in a category based on their score.

The following diagram shows the design for the class `Player`. This includes the properties and methods.

<b>Player</b>	
Score	: INTEGER // initialised to 0
Category	: STRING // "Beginner", "Intermediate", // "Advanced" or "Not Qualified", initialised // to "Not Qualified"
PlayerID	: STRING // initialised with the parameter InputPlayerID
Create()	// method to create and initialise an object using // language-appropriate constructor
SetScore()	// checks that the Score parameter has a valid value // if so, assigns it to Score
SetCategory()	// sets Category based on player's Score
SetPlayerID()	// allows a player to change their PlayerID // validates the new PlayerID
GetScore()	// returns Score
GetCategory()	// returns Category
GetPlayerID()	// returns PlayerID



- (i) The constructor receives the parameter `InputPlayerID` to create the `PlayerID`. Other properties are initialised as instructed in the class diagram.

Write **program code** for the `Create()` constructor method.

Programming language .....

Program code

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..... [5]

(ii) Write **program code** for the following **three** get methods.

Programming language .....

GetScore()

Program code

.....  
.....  
.....  
.....

GetCategory()

Program code

.....  
.....  
.....  
.....

GetPlayerID()

Program code

.....  
.....  
.....  
.....

[4]









- (e) The programmer wants to test that the correct category is set for a player's score.

As stated in **part (d)(v)**, players will be placed in one of the following categories.

Category	Criteria
Advanced	Score is greater than 120
Intermediate	Score is greater than 80 and less than or equal to 120
Beginner	Score is greater than or equal to 50 and less than or equal to 80
Not Qualified	Score is less than 50

Complete the table to provide test data for each category.

Category	Type of test data	Example test data
Beginner	Normal	
	Abnormal	
	Boundary	
Intermediate	Normal	
	Abnormal	
	Boundary	
Advanced	Normal	
	Abnormal	
	Boundary	

[3]

(f) In **part (b)**, the club stored scores in a 1D array. This allows the club to sort the scores.

The following is a sorting algorithm in pseudocode.

```
NumberOfScores ← 5
```

```
FOR Item ← 1 TO NumberOfScores - 1
```

```
    InsertScore ← ArrayData[Item]
```

```
    Index ← Item - 1
```

```
    WHILE (ArrayData[Index] > InsertScore) AND (Index >= 0)
```

```
        ArrayData[Index + 1] ← ArrayData[Index]
```

```
        Index ← Index - 1
```

```
    ENDWHILE
```

```
    ArrayData[Index + 1] ← InsertScore
```

```
ENDFOR
```

(i) Give the name of this algorithm.

..... [1]

(ii) State the name of **one** other sorting algorithm.

..... [1]



(iii) Complete a dry run of the algorithm using the following trace table.

Item	NumberOfScores	InsertScore	Index	ArrayData				
				0	1	2	3	4
				99	125	121	109	115

[7]

3 Some algorithms can be written using recursion.

(a) State **two** features of recursion.

Feature 1 .....

Feature 2 .....

[2]

(b) Explain what a compiler has to do to implement recursion.

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[3]

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