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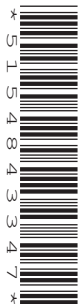
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COMPUTER SCIENCE

9608/43

Paper 4 Further Problem-solving and Programming Skills

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.

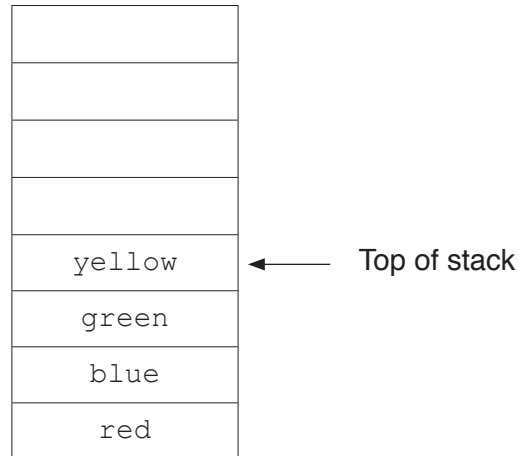
At the end of the examination, fasten all your work securely together.

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**.

.....

.....

.....

.....

.....

.....

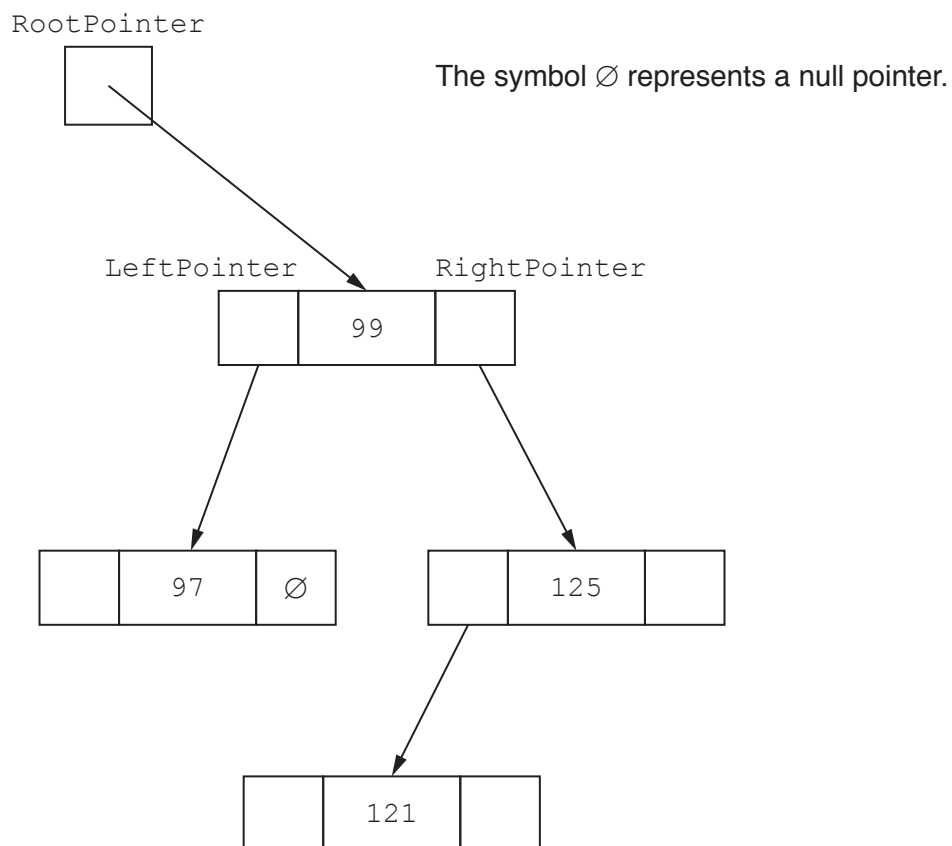
..... [3]

- 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.



- (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.

| Player | |
|---------------|---|
| 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 |

(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]

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.

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

[3]

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