Cambridge International AS & A Level

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Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4658950581

COMPUTER SCIENCE **9608/41**

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.

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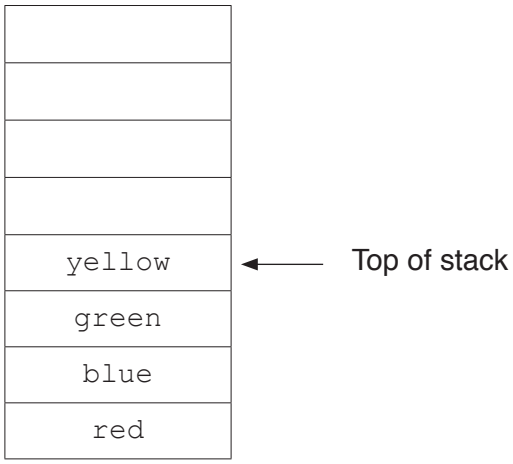
[Turn over

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

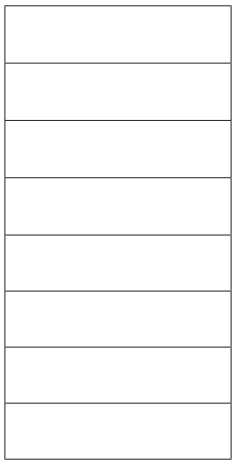


(i) Show the contents of the stack in **part(a)** after the following operations.

```
POP()

PUSH('purple')

PUSH('orange')
```



[1]

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

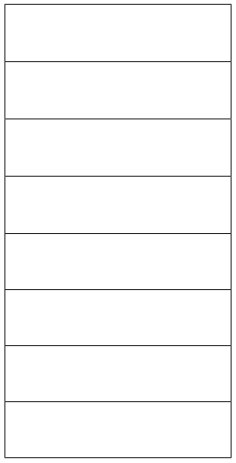
```
POP()

POP()

PUSH('brown')

POP()

PUSH('black')
```



[1]

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

Describe a **queue**.

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..... [3]

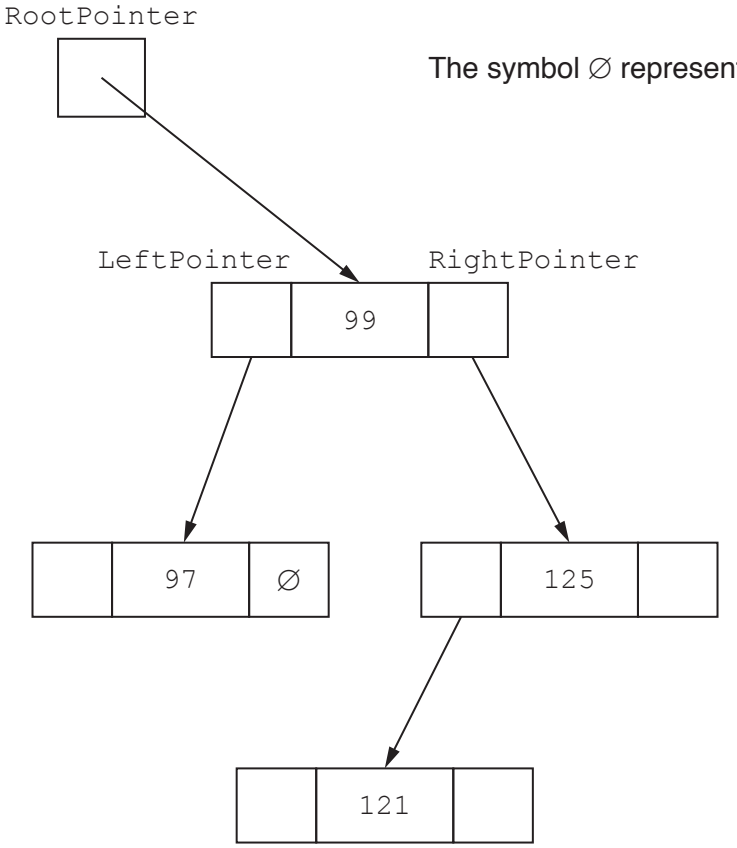
2 A computer games club wants to run a competition. The club needs a system to store the scores achieved in the competition.

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.



[5]

(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

0

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 .....

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..... [3]

(ii) Object-oriented .....

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(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`

(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

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`GetCategory()`

Program code

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`GetPlayerID()`

Program code

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[4]

(iii) The method `SetPlayerID()` asks the user to input the new player ID and reads in this value.

It checks that the length of the `PlayerID` is less than or equal to 15 characters and greater than or equal to 4 characters. If the input is valid, it sets this as the `PlayerID`, otherwise it loops until the player inputs a valid `PlayerID`.

Use suitable input and output messages.

Write **program code** for `SetPlayerID()`.

Programming language .....

Program code

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(iv) The method `SetScore()` checks that its `INTEGER` parameter `ScoreInput` is valid. If it is valid, it is then set as `Score`. A valid `ScoreInput` is greater than or equal to 0 and less than or equal to 150.

If the `ScoreInput` is valid, the method sets `Score` and returns `TRUE`.

If the `ScoreInput` is not valid, the method does not set `Score`, displays an error message, and it returns `FALSE`.

Write **program code** for `SetScore(ScoreInput : INTEGER)`.

Programming language .....

Program code

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(v) Write **program code** for the method `SetCategory()`. Use the properties and methods in the original class definition.

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

Programming language .....

Program code

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(vi) Joanne has played the first game to place her in a category for the competition.

The procedure `CreatePlayer()` performs the following tasks.

- allows the player ID and score to be input with suitable prompts
- creates an instance of `Player` with the identifier `JoannePlayer`
- sets the score for the object
- sets the category for the object
- outputs the category for the object

Write **program code** for the `CreatePlayer()` procedure.

Programming language .....

Program code

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(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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