



Oxford Cambridge and RSA

Friday 24 June 2022 – Morning

A Level Computer Science

H446/02 Algorithms and programming

Time allowed: 2 hours 30 minutes



You can use:

- a ruler (cm/mm)
- an HB pencil

Do not use:

- a calculator



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

| | | | | |
|--|--|--|--|--|
| | | | | |
|--|--|--|--|--|

Candidate number

| | | | |
|--|--|--|--|
| | | | |
|--|--|--|--|

First name(s)

Last name

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.

INFORMATION

- The total mark for this paper is **140**.
- The marks for each question are shown in brackets [].
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **36** pages.

ADVICE

- Read each question carefully before you start your answer.

PLEASE DO NOT WRITE ON THIS PAGE

3

Section A

Answer **all** the questions.

1 A computer program stores data in an array named `words`.

(a) The data in the array needs to be searched for a value that the user inputs.

(i) One example of a searching algorithm is a binary search.

Identify the precondition for a binary search.

.....
..... [1]

(ii) A second example of a searching algorithm is a linear search.

Describe how a linear search works.

.....
.....
.....
.....
.....
.....
.....
.....
.....
..... [4]

(b) The array `words` is defined as a global variable and contains these values:

| | | | | | | |
|---------|--------|-------|-------------|----------|---------|------------|
| "house" | "boat" | "car" | "telephone" | "garden" | "spice" | "elephant" |
|---------|--------|-------|-------------|----------|---------|------------|

The pseudocode function `useWords()` here uses the global array `words`.

The number of words in the array `words` is passed as a parameter.

```
function useWords(numberOfWords : byVal)
    contents = ""
    for count = 0 to numberOfWords - 1
        contents = contents + words[count] + " "
    next count
    return contents
endfunction
```

(i) Identify **two** variables in the function `useWords()`.

- 1
- 2 [2]

(ii) `numberOfWords` is a parameter passed by value.

Describe the difference between passing a parameter by value and by reference.

-
-
-
- [2]

5

(iii) Rewrite the function `useWords()` to use a while loop instead of a for loop.

The function header and close have been written for you.

Write your answer using pseudocode or program code.

```
function useWords(numberOfWords : byVal)
```

.....

.....

.....

.....

.....

.....

.....

.....

.....

```
endfunction
```

[4]

(c) Give **one** benefit and **one** drawback of declaring the array as a global variable instead of a local variable.

Benefit

.....

Drawback

.....

[2]

- (d) Describe **one** feature of an Integrated Development Environment (IDE) that can be used to help write the program **and one** feature that can be used to help test the program.

Write

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

Test

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

[4]

- (e) Functions and procedures are reusable components.

Give **two** benefits of writing a program with reusable components.

1

.....

2

.....

[2]

PLEASE DO NOT WRITE ON THIS PAGE

2 A computer program is being written to store data about students.

Fig. 2 shows a binary search tree that stores data about students.

Each student is represented by their ID number. The current contents of the binary search tree are:

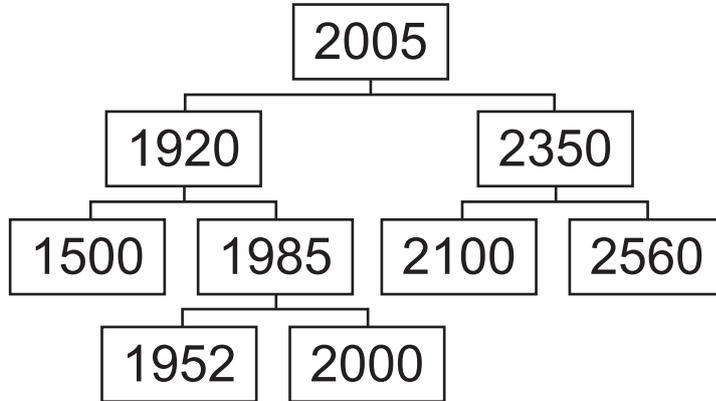


Fig. 2

(a) Identify the root node in the binary tree shown in **Fig. 2**.

.....
..... [1]

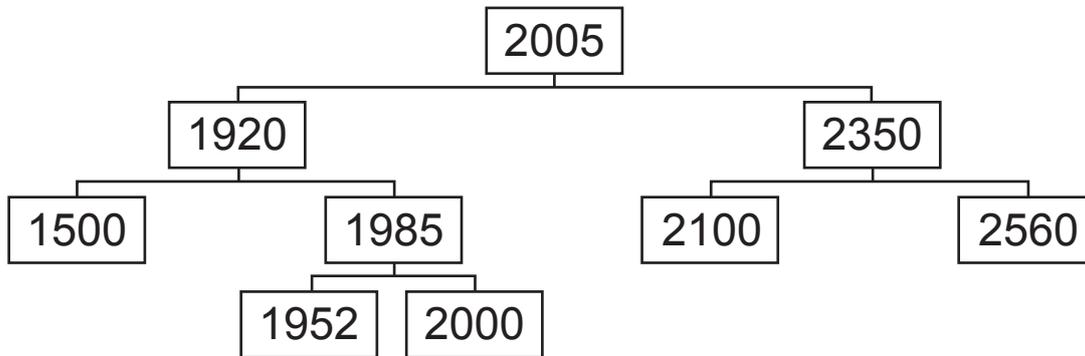
(b) Identify **two** leaf nodes in the binary tree shown in **Fig. 2**.

1
2 [2]

(c) Four more students are added to the binary search tree shown in **Fig. 2** in this order:

1420 2050 2780 2600

Complete the binary search tree here by adding the new students to it.



[4]

3 A bubble sort will sort an array of 50 integer values called `numberArray`.

(a) State why the integer values are stored in an array instead of separate variables.

.....
..... [1]

(b) This bubble sort algorithm is written to sort `numberArray` into ascending numerical order.

Complete this bubble sort algorithm.

```
arrayLength = .....  
tempValue = 0  
do  
    flag = false  
    for y = 0 to arrayLength - .....  
        if numberArray[y] > numberArray[y + 1] then  
            ..... = numberArray[y]  
            numberArray[.....] = numberArray[y + 1]  
            numberArray[y + 1] = .....  
            flag = true  
        endif  
    next y  
until flag == false
```

[5]

4 A programmer is developing an aeroplane simulator. The user will sit in a cockpit and the simulated environment will be displayed on screens around them.

(a) The programmer uses computational methods to design a solution for the program.

(i) Complete the table by writing a definition for each computational method.

| Computational Method | Definition |
|----------------------|------------|
| Abstraction | |
| Decomposition | |

[2]

(ii) Give **three** potential differences between the abstracted aeroplane simulator and reality.

1

.....

2

.....

3

.....

[3]

(iii) Identify **two** reasons why abstraction is used when designing a solution to the problem.

1

.....

2

.....

[2]

(b) Describe how caching can be used in the aeroplane simulator.

.....

.....

.....

..... [2]

PLEASE DO NOT WRITE ON THIS PAGE

5 Fig. 5 shows a graph data structure representing a small section of a parcel delivery network. Each node represents an address where deliveries need to be made. The edges show the possible routes and distances between these deliveries.

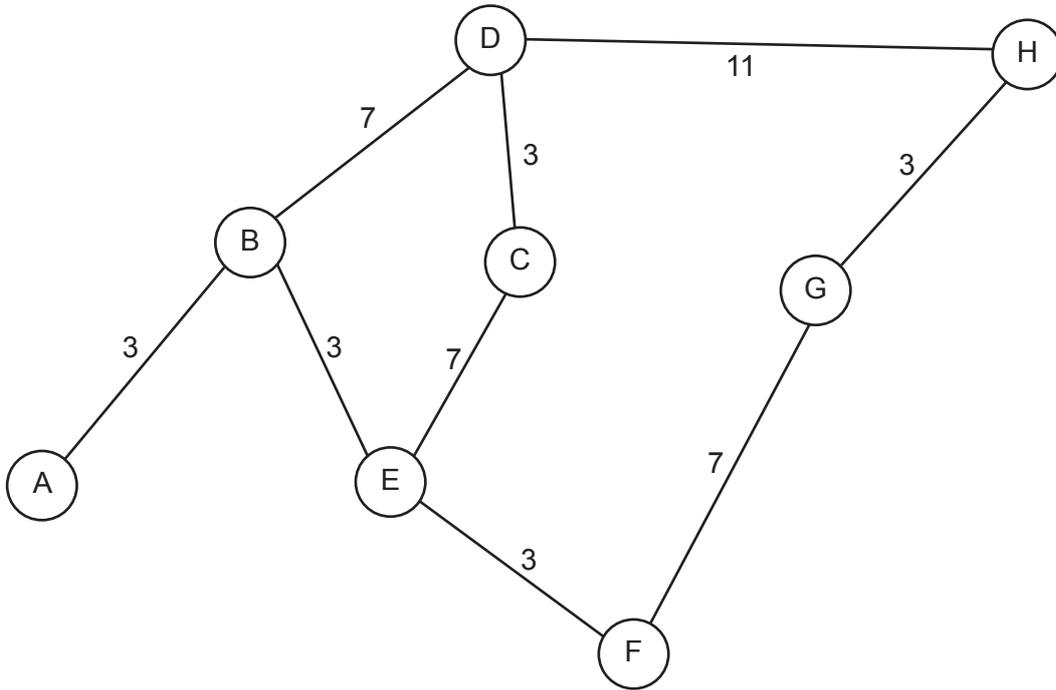


Fig. 5

(a) (i) State **one** way a directed graph is different to an undirected graph.

.....
 [1]

(ii) State **one** way a graph data structure is different to a tree data structure.

.....
 [1]

(b) Give **one** reason why the graph is a visualisation of the problem.

.....
 [1]

(ii) Give a similarity and difference between the performance of Dijkstra’s algorithm and the performance of A* algorithm.

Similarity

.....

Difference

.....

[2]

(d) (i) State why performance modelling is used to test a system.

.....

..... [1]

(ii) Describe how performance modelling can be used in the delivery system.

.....

.....

.....

..... [2]

- 6 A card game uses a set of 52 standard playing cards. There are four suits; hearts, diamonds, clubs and spades. Each suit has a card with a number from; 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13.

The card game randomly gives 2 players 7 cards each. The unallocated cards become known as the deck.

The players then take it in turns to turn over a card. A valid move is a card of the same suit or the same number as the last card played.

The winner is the first player to play all of their cards.

- (a) One component of the game is checking if a move is valid.

Identify **three** other components of the game.

1

2

3

[3]

- (b) A function, `checkValid()`, takes the card the player has selected, and the last card played as parameters.

It returns `true` if the player's move is valid and returns `false` if the player's move is not valid.

- (i) State the reason why `checkValid()` is a function and not a procedure.

.....

..... [1]

- (ii) The programmer will use a branching (selection) construct to make decisions.

Describe the decisions that will be made in the `checkValid()` function and how these change the return values.

.....

.....

.....

.....

.....

..... [3]

- (c) The cards are held in the 2D array `cards`. The first index stores the card number and the second index stores the suit, both as strings.

Write a pseudocode statement or program code to declare the array `cards`.

.....

.....

.....

..... [2]

PLEASE DO NOT WRITE ON THIS PAGE

7 A program uses the recursive function `calculate()`. The function is written in pseudocode.

```
1. function calculate(number : byVal)
2.     if number == 1 then
3.         return number
4.     else
5.         return number + calculate (number - 1)
6.     endif
7. endfunction
```

(a) (i) Give the line number in the algorithm `calculate()` where a recursive call is made.

..... [1]

(ii) State **two** features of any recursive algorithm.

Feature 1

.....

Feature 2

.....

[2]

Section B

Answer **all** the questions.

- 8 A computer uses a stack data structure, implemented using an array, to store numbers entered by the user.

The array is zero based and has 100 locations.

- (a) **Fig. 8** shows the current contents of the stack and the first 9 locations of the array.

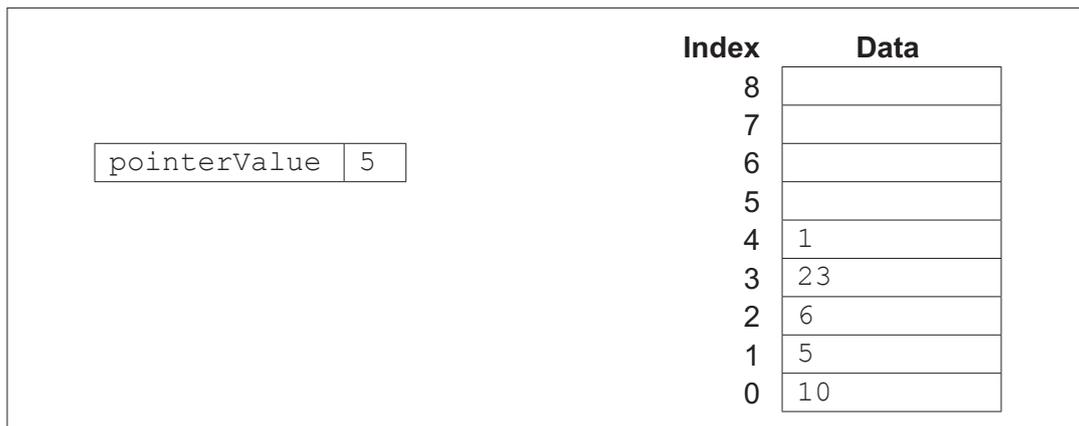


Fig. 8

(i) The function `pop()` removes an item from the stack.

The function `push()` adds an item to the stack that is passed in as a parameter.

Show the contents of the stack and pointer from **Fig. 8** after the following subroutines calls have run.

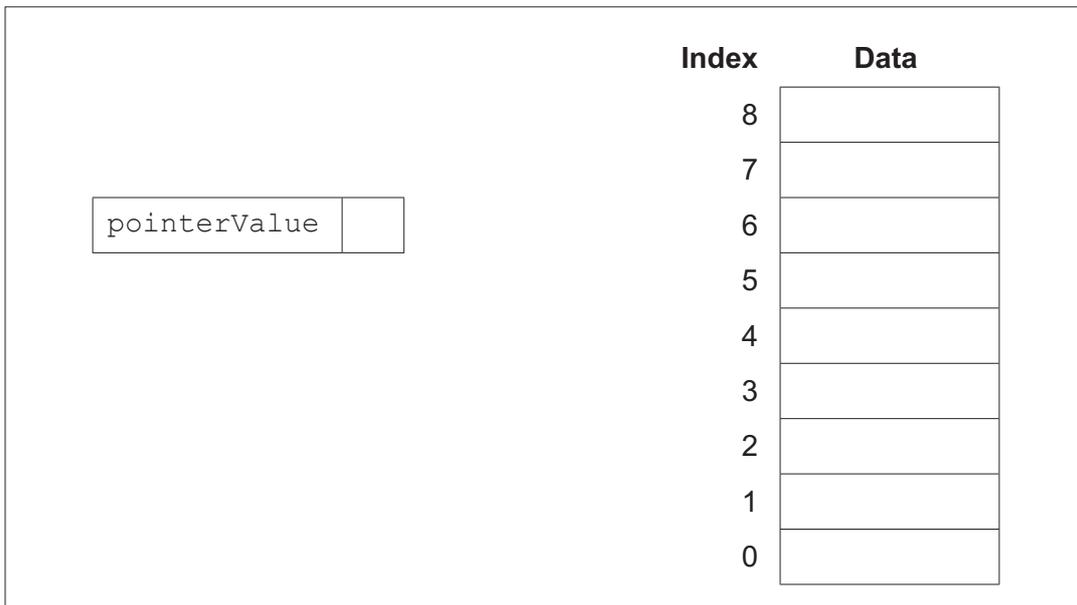
`pop()`

`pop()`

`push(3)`

`push(6)`

`push(7)`



[2]

(ii) State the purpose of `pointerValue`.

.....
..... [1]

- (b) The stack is programmed as an object using object-oriented programming. The design for the class, its attributes and methods are shown:

| |
|--|
| class: stack |
| attributes: private stackArray : Array of integer private pointerValue : integer |
| methods: new() function pop() function push(value) |

- (i) The method `pop()` returns the next value in the stack, or `-1` if the stack is empty.

Complete the pseudocode method `pop()`.

```
public function pop()
    if pointerValue == ..... then
        return .....
    else
        pointerValue = pointerValue .....
        returnValue = stackArray[.....]
        return .....
    endif
endfunction
```

[5]

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

A large area of lined paper for writing answers. It features a vertical margin line on the left side and horizontal dotted lines for writing. The lines are evenly spaced and extend across the width of the page.

A blank sheet of lined paper. On the left side, there is a solid vertical line that serves as a margin. The rest of the page is filled with horizontal dotted lines, providing a guide for writing. The lines are evenly spaced and extend across the width of the page.

A large area of the page is filled with horizontal dotted lines, providing a space for writing answers. A solid vertical line runs down the left side of this area, creating a margin.

OCR

Oxford Cambridge and RSA

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series. If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact The OCR Copyright Team, The Triangle Building, Shaftesbury Road, Cambridge CB2 8EA.

OCR is part of Cambridge University Press & Assessment, which is itself a department of the University of Cambridge.