OCR
Oxford Cambridge and RSA

Monday 22 May 2023 – Afternoon

AS Level Computer Science

H046/02 Algorithms and problem solving

Time allowed: 1 hour 15 minutes

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.
- 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 **70**.
- 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 **16** pages.

ADVICE
- Read each question carefully before you start your answer.

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1 A program uses a bubble sort to sort data into ascending numerical order.

The data is stored in a 0-indexed 1-dimensional array.

(a) Show each stage of a bubble sort to sort this data into ascending numerical order:

1	5	3	9	2	7

You should clearly show and label each pass in your answer.

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

(b) A programmer has partially developed a bubble sort algorithm in pseudocode.

This will partially sort an array of numbers called `numbers` that is passed as a parameter.

```
01 procedure bubbleSort(numbers : byRef)
02    flag = true
03    for x = 0 to numbers.length – 1
04      if numbers[x] > numbers[x + 1] then
05        holdValue = numbers[x]
06        numbers[x] = numbers[x + 1]
07        numbers[x + 1] = holdValue
08        flag = false
09      endif
10    next x
11 endprocedure
```

(i) Explain why the procedure `bubbleSort` accepts the array `numbers` by reference and not by value.

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..... **[3]**

(ii) The programmer has used a `for` loop on line 3 in the procedure `bubbleSort`. A `for` loop is a count controlled loop.

State what is meant by the term 'count controlled loop'.

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

(iii) State the purpose of the variable `holdValue` in the procedure `bubbleSort`.

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..... **[3]**

(iv) The procedure `bubbleSort` will only partially sort the array `numbers` into order.

Describe what the programmer would need to add to the algorithm to enable it to fully sort the numbers into order.

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..... **[2]**

(c) (i) The array `numbers` contains 356 numbers to be sorted by the bubble sort algorithm.

State the maximum number of passes a bubble sort would need to complete to sort 356 numbers into order.

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

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

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

2 Taylor is designing a program for a client who would like to simulate earthquakes on major cities around the world in 3D. The client would like to be able to view any stage of an earthquake such as:

1. the build-up of the earthquake
2. the earthquake taking place
3. the aftershocks of the earthquake.

The client would also like to be able to play the simulation at different speeds. For example, a slow, normal or fast speed.

(a) Give **three** examples of where abstraction can be used in the design of this program.

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[3]

(b) The program will need to accept inputs from the user before playing the simulation.

(i) Identify **two** different inputs for this program.

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2 .....

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[2]

(ii) One decision point in the program will be to decide if the user inputs are suitable or not.

Identify **two** other example decision points in this program.

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[2]

(c) Taylor is deciding which software development methodology to use to write the program. The client has stated that they would like the program as soon as possible and want to be heavily involved during the program creation.

(i) Describe the difference between the spiral model and the waterfall model.

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

(ii) Give **two** reasons why the waterfall model is not suitable for Taylor.

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[2]

(iii) Name **and** describe **one** other model of software development.

Name .....

Description .....

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[2]

3* Nina is writing a computer game using an Integrated Development Environment (IDE). Her friend, James, is writing a computer game using a text-editor which will allow James to create and edit text. James will use a separate compiler.

Discuss the differences between writing and debugging a program using an IDE and a text-editor.

You should include the following in your answer:

- features that are used when writing code
- features that are used when debugging code
- the benefits of using an IDE instead of a text-editor.

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4 A function, `toBinary()`, is needed to calculate the binary value of a denary integer between 0 and 255.

`toBinary()` needs to:

- take an integer value as a parameter
- divide the number by 2 repeatedly, storing a 1 if it has a remainder and a 0 if it doesn't
- combine the remainder values (first to last running right to left) to create the binary number
- return the binary number.

For example, to convert 25 to a binary number the steps are as follows:

25 / 2 = 12 remainder 1
12 / 2 = 6 remainder 0
6 / 2 = 3 remainder 0
3 / 2 = 1 remainder 1
1 / 2 = 0 remainder 1

return value = 11001

(a) Write the function `toBinary()`.

You should write your function using pseudocode or program code.

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(b) The main program:

- asks the user to enter a denary number between 1 and 255
- checks that the input is valid between 1 and 255
- If valid call the function `toBinary()` and pass the input as a parameter
- outputs the return value
- If not valid, repeatedly asks the user to input a number until the number is valid.

Write the algorithm for the main program.

You should write your algorithm using pseudocode or program code.

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5 Layla writes a pseudocode algorithm to:

- input 20 positive numbers into a 0-indexed 1-dimensional array
- output the average (mean) number as a decimal
- output the smallest number
- output the largest number.

The pseudocode algorithm is shown. It contains various errors.

```
01 total = 1

02 smallest = 9999

03 largest = -1

04 for x = 0 to 21

05   dataArray[x] = input("Enter a number")

06   total = total + dataArray[x]

07   if dataArray[x] < largest then

08     largest = dataArray[x]

09   endif

10   if dataArray[x] < smallest then

11     smallest = dataArray[x]

12   endif

13 next x

14 print("Average = " + total * 20)

15 print("Smallest = " + smallest)

16 print("Largest = " + largest)
```

(a) (i) Identify the construct used on lines 01 to 03 in the algorithm.

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

(ii) Identify the construct used on lines 10 to 12 in the algorithm.

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

(b) Identify **two** variables used in this algorithm.

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2 .....

[2]

(c) The algorithm that Layla has written has many errors.

Identify the line number of **four** different errors and write the corrected line of code.

Error 1 line number .....

Error 1 correction .....

Error 2 line number .....

Error 2 correction .....

Error 3 line number .....

Error 3 correction .....

Error 4 line number .....

Error 4 correction .....

[4]

(d) `dataArray` is defined as a local variable within the main program.

(i) State what is meant by a 'local variable'.

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

(ii) Give **one** benefit and **one** drawback of declaring `dataArray` as a local variable in the main program.

Benefit .....

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Drawback .....

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[2]

6 A program stores data in a 1-dimensional array.

(a) The program needs to search the array for a number that is input by the user.

(i) Describe how a linear search will search the data in the array for a number that has been input.

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(ii) State why you would use a linear search rather than a binary search.

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(b) Describe how an array can be used to store and access data in a stack data structure.

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

END OF QUESTION PAPER

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).