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Examiners' report

COMPUTER SCIENCE

H046

For first teaching in 2015

H046/02 Summer 2023 series

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers are also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Paper 2 series overview

Paper 2 focuses on both algorithms and problem solving. In particular, it tests the candidates' ability to analyse and solve problems within specific contexts. Candidates are expected to be able to write algorithms fluently in either pseudocode or program code and to be able to trace algorithms.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• demonstrated good factual knowledge of definitions of terms on the specification • demonstrated an ability to analyse questions and respond with appropriately detailed responses for the number of marks available • demonstrated an ability to trace and discuss standard algorithms such as the linear search and bubble sort • demonstrated an ability to write pseudocode to solve a problem.	• showed some factual knowledge but were less able to show application • produced responses to 'explain' questions that identified a point but lacked an expansion in terms of explanation of the point • struggled to trace the logic of algorithms to find errors within the algorithm • showed an inability to write pseudocode or program code.

Question 1 (a)

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]**

Most candidates clearly showed the steps that would take place in a bubble sort for the date given, with most achieving full marks. Some candidates did not explicitly label each pass as required in the question, but marks were given where the passes could be implied.

Few candidates described the principles of a bubble sort instead of applying it to the data given.

Question 1 (b) (i)

(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]**

Many candidates struggled to go beyond recall of definitions for calling by reference and calling by value and struggled to apply it to the code given and to provide a detailed explanation.

The bubble sort was defined as a procedure and not a function, so if numbers had been passed by value, a copy of the array would have been passed, and any changes made would not have been kept after the procedure had completed execution.

Question 1 (b) (ii)

(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'.

.....

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

Most candidates could accurately define a 'count controlled loop' as one that repeated a predefined number of times, although some candidates gave an ambiguous response that was equally applicable to a conditional loop.

Question 1 (b) (iii)

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

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

Many candidates found it difficult to explain the purpose of the `holdValue` variable in context. Where candidates achieved some of the marks, they most frequently identified `holdValue` as a temporary store that was required to prevent accidental overwriting of data during the swap process. Relatively few were able to accurately describe how the variable allowed the contents of `dataArray[x]` and `dataArray[x+1]` to be swapped.

Exemplar 1

it acts as a temporary varable to hold the value of numbers [x] ~~while~~ before numbers[x] is overwitten so the orginal value is not lost and is instead copied to numbers[x+1]

This exemplar very clearly states exactly how and why the variable `holdValue` is required.

Question 1 (b) (iv)

(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.

.....

.....

.....

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

Many candidates found it challenging to apply knowledge of a bubble sort to the code given. While a pleasing number identified the need to have an outer loop, there were far fewer who were able to expand on this to explain that this was required to repeat the process for the required number of passes, or until no swaps had occurred during a pass.

Question 1 (c) (i)

(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.

.....

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

Many candidates did not appreciate that a bubble sort will require a maximum of n-1 passes in the worst case since the first item in the list will be in position after that number of passes and so would not require an additional pass. The most common incorrect responses were 356, and 356^2 which confused the worst case time complexity $O(n^2)$ with the number of passes.

Question 1 (c) (ii)

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

.....

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

Nearly all candidates could identify an additional sorting algorithm with the most common response being 'Insertion sort'.

Question 2 (a)

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.

1 .....

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2 .....

.....

3 .....

.....

[3]

Most candidates demonstrated that they knew what abstraction was, but a significant number struggled to make clear qualified points. Some candidates gave definitions of abstraction as the removal of unnecessary detail, but this did not answer the question. This was a contextual question that required relevant and qualified points. Responses such as 'the weather' were insufficient, whereas 'removal of the effects of weather' was a valid qualified point.

Exemplar 2

1 Abstraction of the major cities

2 The actual earthquake - so showing where it happens instead of the entire process

3 the buildup ~~of the~~

This exemplar shows a response that has unqualified points that do not show how abstraction can be applied. It highlights factors that could be abstracted, but does not tell us how.

Question 2 (b) (i)

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

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

1 .....

.....

2 .....

.....

[2]

Most candidates successfully identified the relevant potential inputs of city/stage/speed from the given scenario. Some candidates suggested alternative inputs such as 'magnitude of earthquake' which were also given marks as they were valid inputs for a simulation relating to earthquakes.

Question 2 (b) (ii)

(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.

1 .....

.....

2 .....

.....

[2]

Few candidates were given full marks for this question. There was some repetition of checking user input values, which was given in the stem of the question. There were also many statements of possible calculations rather than clearly expressed conditions or questions. More successful responses included decisions such as 'have buildings of a certain type survived the earthquake?'.

Question 2 (c) (i)

(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]**

Most candidates were able to display some knowledge of either the waterfall model or the spiral model of software development and were given some marks for identifying relevant points. However, fewer could analyse the factor they gave and then describe the difference between the two models for that factor.

Question 2 (c) (ii)

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

1 .....

.....

2 .....

.....

[2]

Candidates who demonstrated application of knowledge were able to interpret the requirements of the question stem to determine valid reasons for why the waterfall model of software development was not valid in the context given. Clear responses stated that the waterfall model was a long process, but that the clients wanted the system as soon as possible.

Question 2 (c) (iii)

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

Name .....

Description .....

.....

[2]

Many candidates successfully identified another model of software development. The most popular responses were Agile and Rapid Application Development. Fewer candidates were then able to go on to describe features of the model they had selected.

Question 3

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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..... **[9]**

A pleasing number of candidates could identify and describe a range of features of an IDE, with most being able to demonstrate sufficient knowledge to achieve mark band Level 2. Few candidates displayed a level of evaluative reasoning of sufficient depth to achieve mark band Level 3. More successful responses clearly explained how relevant debugging tools in an IDE led to much greater productivity than a text editor because of the way that they could assist with finding logical errors in code through the use of stepping and tracing. An acknowledgement of the amount of system resources and the complexity of some IDE environments was less often evaluated.

Candidates need to focus on making clear logical arguments with evidence of evaluation (AO3) to be able to achieve mark band 3.

Question 4 (a)

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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.....

..... **[6]**

Very few candidates were able to produce a working function, but many gained some marks.

Some candidates had little idea of the concept of a function and struggled to define one. Many omitted the definition statement or omitted the required parameter and then asked for user input instead.

The standard of pseudocode/code was quite weak. Indentation of constructs was often missing or hard to follow. Mid-range marks were achieved when candidates effectively utilised MOD to determine if the remainder on division by two was odd or even, and then using DIV to find the next term in the sequence.

More successful responses demonstrated an ability to problem solve, think logically, and present clear working functions.

Question 4 (b)

(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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.....

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

Candidates found Question 4 (b) easier to approach than Question 4 (a). Most could write pseudocode to accept a user input. When validating the input to be a value between 1 and 255, there was incorrect use of relational operators with off-by-one errors on occasion. There was also incorrect use of logical operators where *or* was used instead of *and,* and vice-versa. When candidates called `toBinary(inputVal)`, the result was not always stored for later use.

Assessment for learning

When preparing candidates for the examination, they will benefit from a wide range of programming experience.

Questions such as 4 (a) and 4 (b) present an ideal opportunity for developing coded solutions to test and discuss before looking at how the algorithms could be presented as pseudocode.

Question 5 (a) (i)

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.

.....

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

Nearly all candidates correctly identified 'sequence' as the correct construct.

Question 5 (a) (ii)

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

.....

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

Nearly all candidates correctly identified 'selection' as the correct construct.

Question 5 (b)

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

1 .....

2 .....

[2]

Most candidates correctly identified two variables from the given code.

Question 5 (c)

(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]

Most candidates were given some marks, but fewer achieved full marks.

The context of the question indicated that the numbers input were positive integers, but candidates did not always appreciate this.

Question 5 (d) (i)

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

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

.....

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

Few candidates were able to clearly define the term 'local variable'. The concept of scope of variables appeared to be poorly understood, with few able to define that a local variable's scope was that of the function/procedure in which it was declared.

Question 5 (d) (ii)

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

Benefit .....

.....

Drawback .....

.....

[2]

Some candidates confused the terms local variable and global variable and gave definitions the wrong way round. A significant number of responses demonstrated conceptual misconceptions. The contents of `dataArray` could be used in other parts of the program if it was passed as a parameter to a function/procedure, but could not be referenced directly. Responses such as giving 'can't be used anywhere else in the program' as a disadvantage were, therefore, incorrect.

Question 6 (a) (i)

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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..... **[5]**

A pleasingly high number of candidates demonstrated a clear understanding of how a linear search operated and used clear and accurate language. More candidates were clearer in the way that they articulated the steps of the search than in previous series. However, there were still a number of candidates who gave vague responses such as 'check each value until the value input is found' that did not articulate the required steps. Some candidates gave advantages or disadvantages of using a linear search but such responses did not answer the question.

Question 6 (a) (ii)

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

.....

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

Many candidates identified the fact that a linear search can operate on an unordered array whereas a binary search cannot. Some candidates alternatively cited the fact that a linear search could be used when the number of items to search was small, which was valid when qualified by the number of items.

Question 6 (b)

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

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

Candidates need to be mindful of the fact that an array is a static data structure with a predetermined size. This meant that responses that explained how lists could be used to append and remove items were not given marks. This is an area where candidates who only have programming experience of using lists in Python often struggle.

Implementing a stack in an array requires a stack pointer. Those candidates who appreciated this and who clearly had practical experience of modelling push()/pop() operations on a stack were able to articulate how the stack would access array locations at the stack pointer.

Exemplar 3

you can create a one dimensional array and assign two pointers index values pointing to the first item as the bottom and then another pointing to the last as the top. if an item is popped the item with the index position of the top is deleted and the top pointers value decreases by one. if you want to add an item you append to the list to the (index +1) of the top item. you should check if top pointer = bottom pointer, as stack is empty. and if (top+1) is greater than the length of the array to see if the stack is full. **[4]**

This exemplar was one of the few responses to show a clear insight as to how an array can be used to store and access a stack. It makes it clear that a stack pointer is required and goes on to explain how the stack pointer is manipulated when push()/pop() operations are performed.

Misconception

Many candidates were not clear about the difference between an array and a list:

- An array is a static structure whose size cannot be changed.
- Lists are dynamic and support items being removed or appended.

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