Chhetri Academy

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GCSE COMPUTER SCIENCE

2.1

OCR J277 | Specification point 2.1.3

Searching and sorting algorithms

Untiered

Past paper question booklet

10	2018-2025	Untiered
question groups	available papers	tier

Before you begin

1. Show working and use units where appropriate.
2. Use extra paper if you need more space.
3. Print at actual size (100%) for measurement questions.

Name _____ **Date** _____

Whole questions are retained for context; some parts cover other points. Legacy sources are labelled.

4 A library gives each book a code made from the first three letters of the book title in upper case, followed by the last two digits of the year the book was published.

For example, “Poetry from the War”, published in 2012 would be given the code `POE12`.

(a) (i) Complete the following pseudocode for a function definition that will take in the book title and year as parameters and return the book code.

```
01  function librarycode(title, ……)
02      parta = title.subString(0, ……)
03      partb = year.subString(2, 2)
04      …… parta.upper + partb
05  endfunction
```

[3]

(ii) Use pseudocode to write an algorithm that does the following :

- Inputs the title and year of a book from the user.
- Uses the librarycode function above to work out the book code.
- Permanently stores the new book code to the text file `bookcodes.txt`

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(b) Functions and procedures are both examples of sub programs.

(i) Describe **one** difference between a function and a procedure.

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(ii) Describe **two** benefits to a programmer of using sub programs.

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Turn over

(c) The library sorts their books based on the book code.

(i) Show the steps that a merge sort would take to put the following list of book codes into ascending alphabetical order (from A to Z).

POE12 , BAC97 , FLY77 , JAV16 , TAL86 , AND18 , ZAR09 , HOP86

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(ii) Explain **one** advantage of a merge sort compared to a bubble sort.

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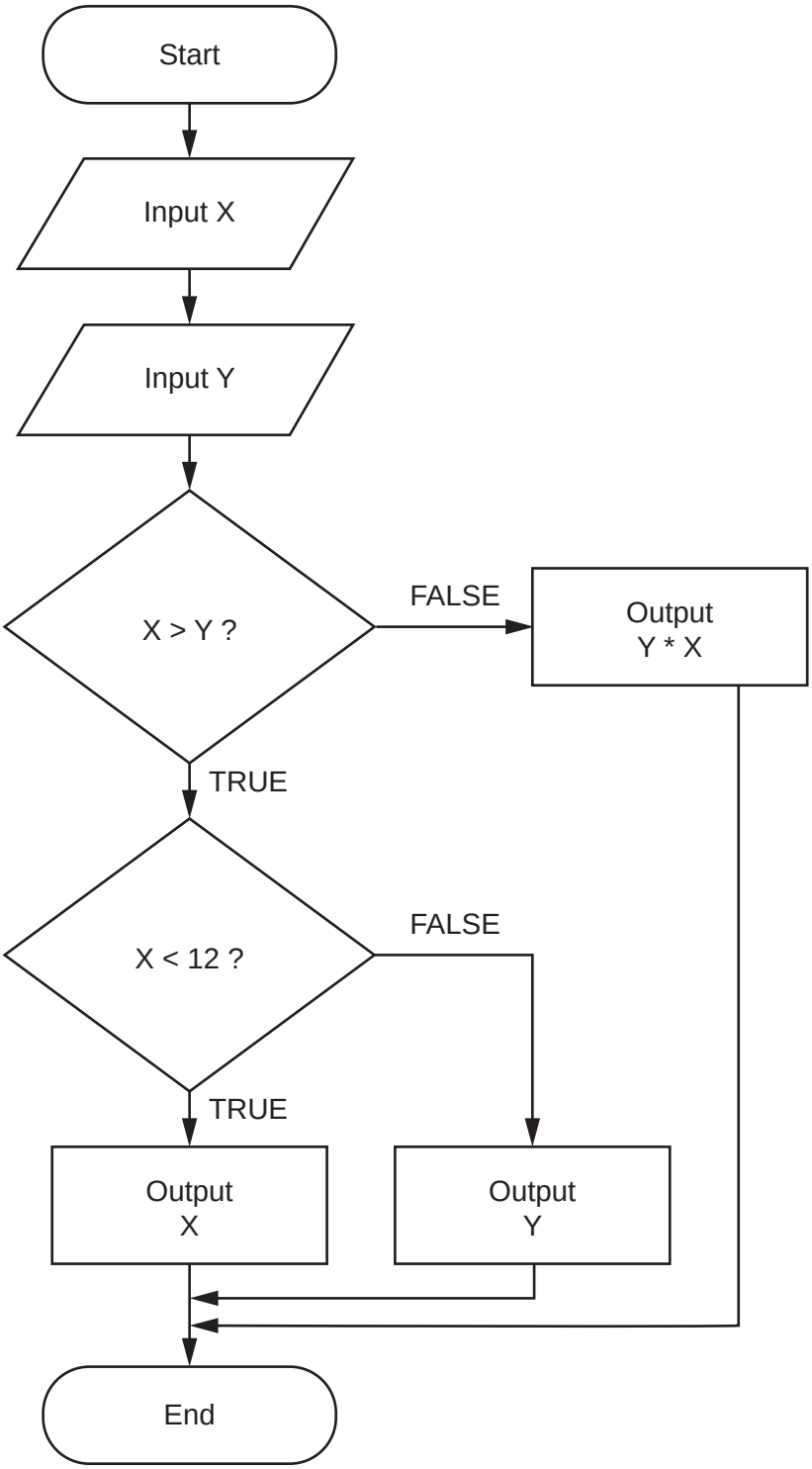
2 A programmer creates an algorithm using a flow chart.



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(a) Complete the table to give the output when each of the following set of values are input into the algorithm as X and Y.

Input value of X	Input value of Y	Output
15	10	
6	5	
2	3	
12	2	

[4]

(b) Write this algorithm using pseudocode.

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The algorithm is written in a high-level language. The high level code must be translated into machine code before a computer processor can execute it.

(c) Describe **two** methods of translating high level code into machine code.

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6 OCR Land is a theme park aimed at children and adults. Entrance tickets are sold online. An adult ticket to OCR Land costs £19.99, with a child ticket costing £8.99. A booking fee of £2.50 is added to all orders.

(a) A function, `ticketprice()`, takes the number of adult tickets and the number of child tickets as parameters. It calculates and returns the total price to be paid.

(i) Use pseudocode to create an algorithm for the function `ticketprice()`.

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(ii) Tick (✓) **one** box to identify the data type of the value returned from the function `ticketprice()`, justifying your choice.

Data type of returned value	Tick (✓) **one** box
Integer	
Real	
Boolean	
String	

Justification .....

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[2]

(b) OCR Land regularly emails discount codes to customers. Each discount code includes a check digit as the last character.

(i) Give **one** benefit of using a check digit for the discount code.

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

(c) A list of valid discount codes is shown below.

[NIC12B, LOR11S, STU12M, VIC08E, KEI99M, WES56O, DAN34S]

(i) State **one** reason why a binary search would not be able to be used with this data.

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

(ii) Give the name of **one** searching algorithm that would be able to be used with this data.

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

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(d) OCR Land keeps track of the size of queues on its rides by storing them in an array with the identifier `queuesize`. It uses the following bubble sort algorithm to put these queue sizes into ascending numerical order.

```
01  swaps = True
02  while swaps
03        swaps = False
04        for p = 0 to queuesize.length-2
05              if queuesize[p] > queuesize[p+1] then
06                    temp = queuesize[p]
07                    queuesize[p] = queuesize[p+1]
08                    queuesize[p+1] = temp
09                    swaps = True
10              endif
11        next p
12  endwhile
```

(i) Explain the purpose of the Boolean variable `swaps` in this bubble sort algorithm.

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(ii) Explain the purpose of lines **06** to **08** in this bubble sort algorithm.

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(iii) Describe **one** way that the maintainability of this algorithm could be improved.

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

(iv) Give the names of **two** other sorting algorithms that could be used instead of bubble sort.

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[2]

(e) One ride in OCR Land has a minimum height of 140 cm to ride alone or 120 cm to ride with an adult.

Create an algorithm that:

- asks the user to input the height of the rider, in centimetres
- if needed, asks if they are riding with an adult
- outputs whether or not they are allowed to ride
- repeats this process until 8 people have been allowed to ride.

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2 An insertion sort is used to put the following words into ascending alphabetical order.

pumpkin	flour	wall	house	wall

(a) Tick (✓) **one** box in each row to identify whether each statement about the insertion sort is true or false.

Statement	True (✓)	False (✓)
The list of words is initially split into a sorted set and an unsorted set.		
The insertion sort uses a divide stage and then a conquer stage.		
The list of words must be in order before the insertion sort can start.		
Each word is inserted into the correct place in the array, one by one.		
The insertion sort will not work because the word “wall” appears twice.		

[5]

(b) The sorted list of words is shown below.

flour	house	pumpkin	wall	wall

Explain how a binary search would be used to try to find whether the word “house” appears in this list.

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

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1 **(a)** Tick (✓) **one** box in each row to identify whether the OCR Reference Language code given is an example of selection or iteration.

OCR Reference Language code	Selection	Iteration

`for i = 1 to 10`
`  print(i)`
`next i`		

`while score != 0`
`  playgame()`
`endwhile`		

`if playerHit() then`
`  score = 0`
`endif`		

`switch bonus:`
`  case 0:`
`  score = 9`
`  case 1:`
`  score = 7`
`  case 2:`
`  score = 5`
`endswitch`		

[4]

(b) Write pseudocode to increment the value held in the variable `score` by one.

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

(c) State the name of each of the following computational thinking techniques.

Breaking a complex problem down into smaller problems.

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Hiding or removing irrelevant details from a problem to reduce the complexity.

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[2]

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3 A program stores the following list of positive and negative numbers. The numbers need sorting into ascending order using a merge sort.

45	12	–99	100	–13	0	17	–27

(a) The first step is to divide the list into individual lists of one number each. This has been done for you.

Complete the merge sort of the data by showing each step of the process.

45	12	–99	100	–13	0	17	–27

[3]

(b) Once the numbers are in order, a binary search can be run on the data.

Describe the steps a binary search will follow to look for a number in a sorted list.

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

(c) A linear search could be used instead of a binary search.

Describe the steps a linear search would follow when searching for a number that is **not** in the given list.

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

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3 An insertion sort is one type of sorting algorithm.

A student has written a pseudocode algorithm to perform an insertion sort on a 1D array `names`.

```
names = ["Kareem", "Sarah", "Zac", "Sundip", "Anika"]
for count = 1 to names.length – 1
    pos = count
    while (pos > 0 and names[pos] < names[pos – 1])
        temp = names[pos]
        names[pos] = names[pos – 1]
        names[pos – 1] = temp
        pos = pos – 1
    endwhile
next count
```

(a) Describe the purpose of the variable `temp` in the insertion sort pseudocode algorithm.

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

(b) An insertion sort contains a nested loop; a loop within a loop. In this pseudocode algorithm the outer loop is a count-controlled loop and the inner loop is a condition-controlled loop.

Explain why the inner loop needs to be a condition-controlled loop.

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

(c) A bubble sort is another type of sorting algorithm.

(i) Describe **one** difference between an insertion sort and a bubble sort.

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

(ii) Describe **two** similarities between an insertion sort and a bubble sort.

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2 .....

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[2]

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3

(a) State what is meant by the term syntax error. Give **one** example of a syntax error in a program.

Definition .....

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Example .....

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[2]

(b) A student writes an algorithm to input two numbers and add them together to create a total.

If the total is between 10 and 20 inclusive, `"success"` is output.

If the total is not between 10 and 20 inclusive, `"warning"` is output.

```
01 num1 = input("Enter a number")
02 num2 = input("Enter a number")
03 total = num1 + num1
04 if total >= 10 then
05     print("success")
06 else
07     print("warning")
08 endif
```

The algorithm does not work correctly.

Identify the line number of the **two** logic errors in the algorithm and refine the code to correct each logic error.

Line number .....

Correction .....

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Line number .....

Correction .....

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[4]

(c)

(i) Show how a binary search will be used to find the number 10 in the following data set:

1 2 5 6 7 10 20

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

(ii) State **one** pre-requisite for a binary search algorithm.

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(iii) Tick (✓) **one** box to identify the name of the sorting algorithm that splits data into individual items before recombining in order.

- ☐ Bubble sort
- ☐ Insertion sort
- ☐ Merge sort

[1]

9 Students take part in a sports day. The students are put into teams.

Students gain points depending on their result and the year group they are in. The points are added to the team score.

The team with the most points at the end of the sports day wins.

(a) Data about the teams and students is stored in a sports day program.

(i) Identify the most appropriate data type for each variable used by the program.

Each data type must be different.

Variable	Example	Data type
`teamName`	`"Super-Team"`	
`studentYearGroup`	`11`	
`javelinThrow`	`18.2`	

[3]

(ii) The student names for a team are stored in an array with the identifier `theTeam`

An example of the data in this array is shown:

Index	0	1	2	3	4	5
Data	Ali	Eve	Ling	Nina	Sarah	Tom

`theTeam`

A linear search function is used to find whether a student is in the team. The function:

- takes a student name as a parameter
- returns `True` if the student name is in the array
- returns `False` if the student name is **not** in the array.

Complete the design of an algorithm for the linear search function.

```
function linearSearch(studentName)

    for count = 0 to ……………………..……

        if theTeam[……..……..……] == ……..…… then

             return ……..……

        endif

    next count

    return False

endfunction
```

[4]

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(b) This algorithm calculates the number of points a student gets for the distance they throw in the javelin:

```
01   javelinThrow = input("Enter distance")
02   yearGroup = input("Enter year group")
03   if javelinThrow >= 20.0 then
04       score = 3
05   elseif javelinThrow >= 10.0 then
06       score = 2
07   else
08       score = 1
09   endif
10   if yearGroup != 11 then
11       score = score * 2
12   endif
13   print("The score is", score)
```

Complete the trace table for the algorithm when a student in year 10 throws a distance of 14.3

You may not need to use all the rows in the table.

Line number	javelinThrow	yearGroup	score	Output

[4]

(c) The height a student jumps in the high jump needs to be input and validated.
The height is entered in centimetres (cm) and must be between 40.0 and 180.0 inclusive.

(i) Write an algorithm to:
- take the height jumped as input
- output `"VALID"` or `"NOT VALID"` depending on the height input.

You must use **either**:
- OCR Exam Reference Language, **or**
- A high-level programming language that you have studied.

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

(ii) The algorithm is tested using a range of tests.

Complete the table to identify an example of test data for each type of test.

Test data (height jumped in cm)	Type of test	Expected output
	Normal	`"VALID"`
	Boundary	`"VALID"`
	Erroneous	`"NOT VALID"`

[3]

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(d) The individual results for each student in each event are stored in a database.

The database table `TblResult` stores the times of students in the 100 m race. Some of the data is shown:

StudentID	YearGroup	TeamName	Time
11GC1	11	Valiants	20.3
10VE1	10	Super-Team	19.7
10SM1	10	Super-Team	19.2
11JP2	11	Champions	19.65

Complete the SQL statement to show the Student ID and team name of all students who are in year group 11

```
SELECT StudentID, .....

FROM .....

.....
```

[4]

(e) Abstraction and decomposition have been used in the design of the sports day program.

(i) Identify **one** way that abstraction has been used in the design of this program.

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

(ii) Identify **one** way that decomposition has been used in the design of this program.

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

(f) An algorithm works out which team has won (has the highest score).

Write an algorithm to:
- prompt the user to enter a team name and score, or to enter "stop" to stop entering new teams
- repeatedly take team names and scores as input until the user enters "stop"
- calculate which team has the highest score
- output the team name and score of the winning team in an appropriate message.

You must use **either**:
- OCR Exam Reference Language, **or**
- A high-level programming language that you have studied

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[6]

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

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3

(a) Show the steps that a merge sort would take to put the data set into ascending numerical order.

2, 7, 3, 1, 9, 6, 5, 4

[4]

(b) Tick (✓) **one** box in each table to complete the descriptions.

An insertion sort…

	Tick (✓) **one** box
uses an array of numbers with a sorted part and unsorted part	
picks out the middle value to begin with	
merges arrays of numbers together	

A bubble sort compares pairs of values and then:

	Tick (✓) **one** box
always swaps them	
swaps them if they are in the correct order	
swaps them if they are in the incorrect order	

A sorting algorithm can sort data in an array. An array:

	Tick (✓) **one** box
is declared with a fixed length	
stores multiple values that cannot be changed while the program is running	
can only be declared with a maximum of one-dimension (1D)	

[3]

(c) An algorithm can be used to search for a value in an array. The algorithm follows these steps:

- compares the first value in the array to the value being searched for
- stops if the comparison is `true`
- moves to the next value in the array if the comparison if `false`.

(i) Give the name of the searching algorithm described.

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

(ii) Identify **one other** condition that will cause the algorithm to stop.

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

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