Please write clearly in block capitals.

Centre number						Candidate number				

Surname ____________________

Forename(s) ____________________

Candidate signature ____________________
I declare this is my own work.

GCSE COMPUTER SCIENCE

Paper 1 Computational thinking and programming skills – Python

Friday 19 May 2023 Afternoon Time allowed: 2 hours

Materials
- There are no additional materials required for this paper.
- You must **not** use a calculator.

Instructions
- Use black ink or black ball-point pen. Use pencil only for drawing.
- Answer **all** questions.
- You must answer the questions in the spaces provided.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Questions that require a coded solution must be answered in Python.
- You should assume that all indexing in code starts at 0 unless stated otherwise.

Information
The total number of marks available for this paper is 90.

For Examiner's Use	
Question	Mark
1	
2–3	
4–5	
6–7	
8–9	
10–11	
12	
13–14	
15	
16	
TOTAL	

Advice

For the multiple-choice questions, completely fill in the lozenge alongside the appropriate answer.

CORRECT METHOD ● WRONG METHODS

If you want to change your answer you must cross out your original answer as shown.

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown.

Do not write outside the box

Answer **all** questions.

0 1 **Figure 1** shows an algorithm, represented using pseudo-code, which assigns a different value to four variables.

Figure 1

```
country ← 'United States of America'
state ← 'California'
city ← 'San Francisco'
landmark ← 'Alcatraz Island'
```

0 1 . 1 Define the term **algorithm**.

[2 marks]

____

____

____

0 1 . 2 The variable `x` is assigned a value using the statement:

```
x ← LEN(state)
```

Using **Figure 1**, what is the value of `x`?

Shade **one** lozenge.

[1 mark]

A	`1`	⬭
B	`5`	⬭
C	`10`	⬭
D	`12`	⬭

0 1 . 3 What is the result of concatenating the contents of the variables `city` and `landmark` in **Figure 1**?

Shade **one** lozenge.

[1 mark]

A	`San Francisco Alcatraz Island`	⬭
B	`San Francisco,Alcatraz Island`	⬭
C	`San Francisco, Alcatraz Island`	⬭
D	`San FranciscoAlcatraz Island`	⬭

0 1 . 4 The subroutine `SUBSTRING` extracts characters from a given string.

For example, `SUBSTRING(3, 5, 'Computing')` would return `put`

The variable `y` is assigned a value using the statement:

```
y ← SUBSTRING(4, 7, landmark)
```

Using **Figure 1**, what is the value of `y`?

Shade **one** lozenge.

[1 mark]

A	`Alca`	⬭
B	`Atra`	⬭
C	`land`	⬭
D	`traz`	⬭

Question 1 continues on the next page

Turn over ►

Figure 1 has been included again below.

Figure 1

```
country ← 'United States of America'
state ← 'California'
city ← 'San Francisco'
landmark ← 'Alcatraz Island'
```

0 1 . 5 The subroutine `POSITION` finds the first position of a character in a string.

For example, `POSITION('Computing', 'p')` would return `3`

The variable `z` is assigned a value using the statement:

```
z ← POSITION(landmark, 't')
```

Using **Figure 1**, what value is assigned to `z`?

Shade **one** lozenge.

[1 mark]

A `-1` ⬭

B `3` ⬭

C `4` ⬭

D `5` ⬭

6

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Turn over ►

0 2 **Figure 2** shows an algorithm that uses integer division which has been represented using pseudo-code.

- Line numbers are included but are not part of the algorithm.

Figure 2

```
1   again ← True
2   WHILE again = True
3      a ← USERINPUT
4      IF a > 0 THEN
5         counter ← 0
6         WHILE a > 0
7            a ← a DIV 3
8            counter ← counter + 1
9         ENDWHILE
10     ELSE
11        again ← False
12     ENDIF
13     OUTPUT a
14  ENDWHILE
```

Integer division is the number of times one integer divides into another, with the remainder ignored.

For example:

- `14 DIV 5` evaluates to `2`
- `25 DIV 3` evaluates to `8`

0 2 . 1 Where is iteration **first** used in the algorithm in **Figure 2**?

Shade **one** lozenge.

[1 mark]

A Line number 2

B Line number 4

C Line number 6

D Line number 11

0 2 . 2 In the algorithm in **Figure 2**, what will be output when the user input is `10`?

Shade **one** lozenge.

[1 mark]

A	`0`	⬭
B	`1`	⬭
C	`2`	⬭
D	`4`	⬭

0 2 . 3 In the algorithm in **Figure 2**, what is the largest possible value of the variable `counter` when the user input is `36`?

Shade **one** lozenge.

[1 mark]

A	`0`	⬭
B	`2`	⬭
C	`4`	⬭
D	`5`	⬭

0 3 Explain **one** advantage of the structured approach to programming.

[2 marks]

___

___

___

___

5

0 4 **Figure 3** shows a program written in Python that calculates the area of a rectangle or the volume of a box from the user inputs.

Figure 3

```
def calculate(width, length, height):
   if height == -1:
      return width * length
   else:
      return width * length * height

numOne = int(input("Enter width: "))
numTwo = int(input("Enter length: "))
numThree = int(input("Enter height, -1 to ignore: "))

answer = calculate(numOne, numTwo, numThree)

if numThree == -1:
   print(f"Area {answer}")
else:
   print(f"Volume {answer}")
```

0 4 . 1 Complete the trace table using the program in **Figure 3**.

[3 marks]

`numOne`	`numTwo`	`numThree`	Final output
5	6	-1	
10	4	0	
3	5	10	

0 4 . 2 Describe **one** way that the program in **Figure 3** could be made more robust.

[1 mark]

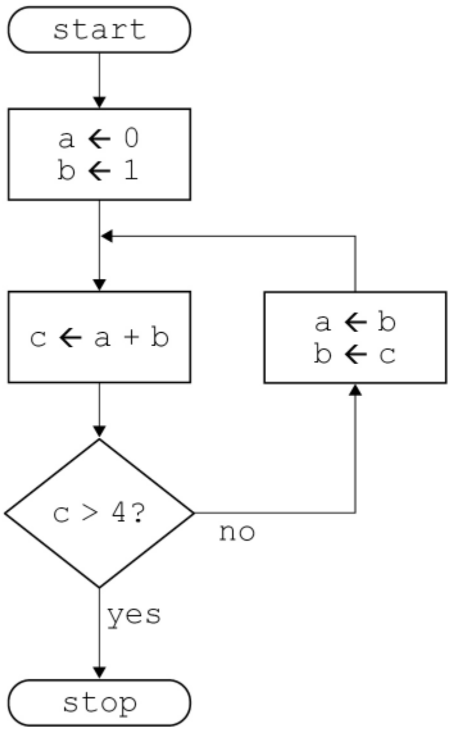
____

____

____

0 5 **Figure 4** shows an algorithm presented as a flowchart.

Figure 4



Complete the trace table for the algorithm in **Figure 4**.

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

[3 marks]

a	b	c

—
7

0 6 **Figure 5** shows an algorithm represented using pseudo-code.

The algorithm is for a simple authentication routine.

The pseudo-code uses a subroutine `getPassword` to check a username:

- If the username exists, the subroutine returns the password stored for that user.
- If the username does not exist, the subroutine returns an empty string.

Parts of the algorithm are missing and have been replaced with the labels L1 to L4.

Figure 5

```
login ← False
REPEAT
   username ← ''
   WHILE username = ''
      OUTPUT 'Enter username: '
      username ← L1
   ENDWHILE
   password ← ''
   WHILE password = ''
      OUTPUT 'Enter password: '
      password ← USERINPUT
   ENDWHILE
   storedPassword ← getPassword(L2)
   IF storedPassword = L3 THEN
      OUTPUT 'L4'
   ELSE
      IF password = storedPassword THEN
         login ← True
      ELSE
         OUTPUT 'Try again.'
      ENDIF
   ENDIF
UNTIL login = True
OUTPUT 'You are now logged in.'
```

Figure 6

`-1`	`OUTPUT`	`0`
`username`	`True`	`SUBROUTINE`
`1`	`User not found`	`''`
`USERINPUT`	`password`	`Wrong password`

State the items from **Figure 6** that should be written in place of the labels in the algorithm in **Figure 5**.

You will not need to use all the items in **Figure 6**.

[4 marks]

L1 ____________________

L2 ____________________

L3 ____________________

L4 ____________________

Turn over for the next question

Do not write outside the box

0 7 A theme park charges £15 per person for a daily ticket. If there are six or more people in a group, the group is given a £5 discount.

Write a Python program to calculate the total charge for a group of people visiting the theme park.

The program must:

- get the user to enter the number of people in a group
- calculate the total charge by:
  - charging £15 per person
  - reducing the total charge by £5 if there are six or more people
- output the total charge.

You **should** use indentation as appropriate, meaningful variable name(s) and Python syntax in your answer.

The answer grid below contains vertical lines to help you indent your code.

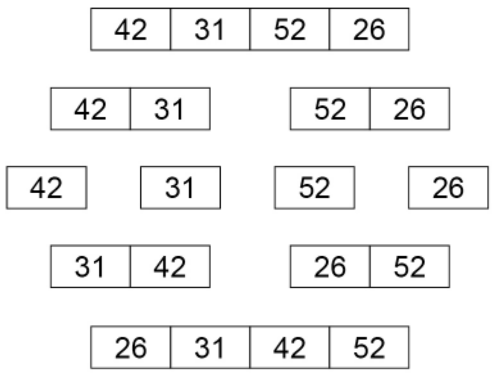
[6 marks]

10

Do not write outside the box

0 8 **Figure 7** shows a merge sort being carried out on a list.

Figure 7



Explain how the merge sort algorithm works.

[4 marks]

Turn over ►

0 9 **Figure 8** shows an algorithm, written using pseudo-code, that uses a `RECORD` data structure for storing information about a film.

Each record stores four pieces of information about a film:

- film title
- certificate (eg 12A, PG)
- year the film was made
- if the film is currently being shown at a cinema.

There are records for three films and these films are stored alphabetically in an array called `filmCollection`.

The pseudo-code outputs the title of the newest of the three films.

- Part of the algorithm has been replaced by the label L1.

Figure 8

```
RECORD Film
   title : String
   certificate : String
   year : Integer
   beingShown : Boolean
ENDRECORD

hulk ← Film('Hulk', '12A', 2005, False)
ironMan ← Film('Iron Man', '12A', 2008, False)
antMan ← Film('Ant-Man', '12A', 2015, False)
filmCollection ← [antMan, hulk, ironMan]
year ← 0
position ← 0

FOR i ← 0 TO L1
   IF filmCollection[i].year > year THEN
      year ← filmCollection[i].year
      position ← i
   ENDIF
ENDFOR

OUTPUT filmCollection[position].title, ' is the
newest film'
```

0 9 . 1 How many different values can the field `beingShown` have?

Shade **one** lozenge.

[1 mark]

A 2 ⬭

B 3 ⬭

C 128 ⬭

D 256 ⬭

0 9 . 2 Which assignment statement changes the year the film *Hulk* was made to 2003?

Shade **one** lozenge.

[1 mark]

A `hulk.year ← 2003` ⬭

B `filmCollection[0].year ← 2003` ⬭

C `Film(year) ← 2003` ⬭

D `hulk(year) ← 2003` ⬭

0 9 . 3 What should the label L1 in **Figure 8** be replaced by?

Shade **one** lozenge.

[1 mark]

A `3` ⬭

B `LEN(filmCollection)` ⬭

C `LEN(filmCollection) - 1` ⬭

D `Position` ⬭

0 9 . 4 Write a pseudo-code statement that updates the `antMan` record to show that the film is currently being shown at the cinema.

[1 mark]

___

8

1 0 **Figure 9** shows an algorithm, represented in pseudo-code, used to display students' test scores. The algorithm does not work as expected and the teacher wants to find the error.

The algorithm should display three test scores for each student:

- Natalie has results of 78, 81 and 72
- Alex has results of 27, 51 and 54
- Roshana has results of 52, 55 and 59.

- Line numbers are included but are not part of the algorithm.

Figure 9

```
1   names ← ['Natalie', 'Alex', 'Roshana']
2   scores ← [78, 81, 72, 27, 51, 54, 52, 55, 59]
3   count ← 0
4   FOR i ← 0 TO 2
5      person ← names[i]
6      OUTPUT 'Student: ', person
7      FOR j ← 0 TO 1
8         OUTPUT j + 1
9         result ← scores[i * 3 + j]
10        OUTPUT result
11        count ← count + 1
12     ENDFOR
13  ENDFOR
```

1 0 . 1 Complete the trace table for the algorithm shown in **Figure 9**.

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

[5 marks]

count	i	person	j	result

1 0 . 2 How could the error in the algorithm in **Figure 9** be corrected?

Shade **one** lozenge.

[1 mark]

A	Change line number 3 to:	`count ← -1`	⬭
B	Change line number 4 to:	`FOR i ← 1 TO 4`	⬭
C	Change line number 7 to:	`FOR j ← 0 TO 2`	⬭
D	Change line number 9 to:	`result ← scores[j * 3 + i]`	⬭

Turn over for the next question

1 1 **Figure 10** shows part of an algorithm that has been written in pseudo-code.

There is an error in the algorithm.

The algorithm should:
- get the start year and end year from the user
- check that the start year is before the end year
- check that the start year is before 2000
- calculate the difference between the two years after a valid start year has been entered.

- Line numbers are included but are not part of the algorithm.

Figure 10

```
1   validChoice ← False
2   REPEAT
3      difference ← -1
4      OUTPUT 'Enter a start year '
5      startYear ← USERINPUT
6      OUTPUT 'Enter an end year '
7      endYear ← USERINPUT
8      IF startYear ≥ endYear THEN
9         OUTPUT 'Start year must be before end year'
10     ELSE
11        IF startYear < 2000 THEN
12           OUTPUT 'Start year must be before 2000'
13        ELSE
14           validChoice ← True
15        ENDIF
16     ENDIF
17  UNTIL validChoice = True
18  difference ← endYear - startYear
19  OUTPUT difference
```

1 1 . 1 **Table 1** shows three tests used to check the algorithm in **Figure 10**.

Complete the table to show what the values of the `validChoice` and `difference` variables would be for the given test data.

[4 marks]

Table 1

Test type	**Test data**		`validChoice`	`difference`
Normal	`startYear`	`1995`		
	`endYear`	`2010`		
Erroneous	`startYear`	`2015`		
	`endYear`	`2000`		
Boundary	`startYear`	`2000`		
	`endYear`	`2023`		

1 1 . 2 The algorithm in **Figure 10** contains a logic error on **line 11**.

Describe how the error on **line 11** can be corrected.

[1 mark]

____

____

11

Turn over for the next question

1 2 . 1 **Figure 11** shows a binary search algorithm that has been programmed in Python.

Figure 11

```
animals = ["cat", "dog", "hippo", "llama", "ox",
"rat", "tiger", "wolf"]
animalToFind = input("What animal would you like to
find? ")
validAnimal = False
start = 0
finish = len(animals) - 1
while validAnimal == False and start <= finish:
   mid = (start + finish) // 2
   if animals[mid] == animalToFind:
      validAnimal = True
   elif animalToFind > animals[mid]:
      start = mid + 1
   else:
      finish = mid - 1
print(validAnimal)
```

Complete the trace table for the program in **Figure 11** if the user input is `wolf`

Part of the table has already been filled in.

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

[4 marks]

animalToFind	**validAnimal**	**start**	**finish**	**mid**
wolf	False	0	7	3

1 2 . 2 **Figure 12** shows a line of Python code that creates a list of fruit names.

Figure 12

```
fruits = ["banana", "apple", "orange", "pear",
          "grape", "pineapple"]
```

Extend the program in **Figure 12**. Your answer must be written in Python.

The program should get the user to enter a word and perform a **linear** search on the list `fruits` to find if the word is in the list or not.

The program should:

- ask the user what word they would like to find
- output the message `True` if the word is found
- output the message `False` if the word is not found.

You must write your own linear search routine and **not** use any built-in search function available in Python.

You **should** use indentation as appropriate, meaningful variable name(s) and Python syntax in your answer.

The answer grid below contains vertical lines to help you indent your code.

[7 marks]

```
fruits = ["banana", "apple", "orange", "pear",
          "grape", "pineapple"]
```

Question 12 continues on the next page

Turn over ►

1 2 . 3 State why a binary search cannot be used on the list `fruits`

[1 mark]

1 2 . 4 **Figure 13** shows an algorithm, represented using pseudo-code, that should display currency names in reverse alphabetical order, starting with `yen`.

There are errors in the logic of the algorithm.

- Line numbers are included but are not part of the algorithm.

Figure 13

```
1    SUBROUTINE diffCurrencies(currencies)
        currencies ← ['baht', 'dollar', 'euro',
2                      'koruna', 'lira', 'rand',
                       'rupee', 'yen']
3       RETURN currencies[x]
4    ENDSUBROUTINE
5
6    FOR i ← 8 TO 0 STEP 1
7       OUTPUT(diffCurrencies(i))
8    ENDFOR
```

Rewrite **line 1** and **line 6** from **Figure 13** to make the algorithm work as intended.

[3 marks]

Line 1 ____

____

Line 6 ____

____

15

Turn over for the next question

Do not write outside the box

1 3 A programmer is writing a game. The game uses a 3 x 3 grid containing nine squares.

Figure 14

	A	B	C
1			
2			
3			X

In the game, a square on the grid is referred to by a letter and a number.
For example, square **C3** in **Figure 14** contains an X.

Figure 15 shows part of a Python program that checks the grid reference entered by a player.
The grid reference is valid if:
- there are exactly two characters
- the first character entered is A, B or C
- the second character entered is 1, 2 or 3.

Figure 15

```
check = False
while check == False:
   square = ""
   while len(square) != 2:
      square = input("Enter grid reference (eg C2): ")
      square = square.upper()
```

The Python function `upper()` converts letters into uppercase, eg `b1` would be converted to `B1`

Extend the program from **Figure 15** so it completes the other checks needed to make sure a valid grid reference is entered.

Your extended program must:
- use the variable `check`
- repeat the following steps until a valid grid reference is entered:
  - get the user to enter a grid reference
  - output an appropriate message if the grid reference entered is not valid.

You **should** use indentation as appropriate, meaningful variable name(s) and Python syntax in your answer.

The answer grid contains vertical lines to help you indent your code.

[6 marks]

Do not write outside the box

```
check = False
while check == False:
    square = ""
    while len(square) != 2:
        square = input("Enter grid reference (eg C2): ")
        square = square.upper()
```

Turn over ►

1 4 50 students have voted for the music genre they like best.

Figure 16 shows an **incomplete** algorithm, represented using pseudo-code, designed to output the highest or lowest results of the vote.

The programmer has used a two-dimensional array called `results` to store the genre and the number of votes for each genre.

Parts of the algorithm are missing and have been replaced with the labels L1 to L3.

Figure 16

```
SUBROUTINE showResults(method, numberOfGenres)
   results ← [['Pop', 'Post-Punk', 'Techno', 'Metal',
               'Dance'], ['7', '19', '14', '1', '9']]
   pos ← 0
   high ← -1
   IF method = 'HIGHEST' THEN
      FOR i ← 0 TO numberOfGenres - 1
         Votes ← STRING_TO_INT(results[L1][i])
         IF votes > high THEN
            high ← votes
            pos ← L2
         ENDIF
      ENDFOR
   ELSE
      OUTPUT 'not yet working'
   ENDIF
   IF high ≠ -1 THEN
      OUTPUT results[0][pos], ' with ', results[1][pos]
   ENDIF
ENDSUBROUTINE

OUTPUT 'Show the genre with the HIGHEST or LOWEST number
of votes? '
method ← USERINPUT
showResults(L3, 5)
```

State what should be written in place of the labels L1 to L3 in the algorithm in **Figure 16**.

[3 marks]

L1 ______________________________

L2 ______________________________

L3 ______________________________

9

Turn over for the next question

1 5 A group of people have a meal in a restaurant. Instead of one person paying for the whole meal, each person will pay for what they eat.

Write a Python program that asks each person in the group how much they are paying towards the meal and works out when the bill is fully paid. Each person can pay a different amount.

The program should:

- get the user to enter the total amount of the bill
- get a person to enter how much they are paying towards the bill
- subtract the amount entered from the bill:
  - if the amount left to pay is more than `0`, output how much is left to pay and repeat until the amount left to pay is `0` or less
  - if the amount left to pay is `0`, then output the message `Bill paid`
  - if the amount left to pay is less than `0`, then output the message `Tip is` and the difference between the amount left to pay and `0`

You **should** use indentation as appropriate, meaningful variable name(s) and Python syntax in your answer.

The answer grid below contains vertical lines to help you indent your code.

[8 marks]

8

Turn over ►

1 6 Question **16** is about a dice game played against a computer.

The aim of the game is to get as close to a score of 21 as you can, without going over 21. If your score goes over 21 then you lose.

The player's score starts at 0.

For each turn:

- two dice (each numbered from 1 to 6) are rolled
- the total of the two dice rolls is added to the player's score
- the value of each dice and the player's new total is output
- if the current score is less than 21, the player is asked if they would like to roll the dice again: if the player says yes, they get another turn; otherwise, the game ends.

At the end of the game, the program should work as follows:

- if the final score is 21, output a message to say the player has won
- if the final score is greater than 21, output a message to say the player has lost
- if the final score is less than 21, the program generates a random number between 15 and 21 inclusive:
  - o if this random number is greater than the player's final score, output a message to say the player has lost
  - o otherwise, output a message to say the player has won.

Figure 17 shows the output of a program that plays this dice game.

Figure 17

```
Roll 1: 1
Roll 2: 4
Current score: 5
Would you like to roll again? yes

Roll 1: 1
Roll 2: 6
Current score: 12
Would you like to roll again? yes

Roll 1: 1
Roll 2: 2
Current score: 15
Would you like to roll again? yes

Roll 1: 6
Roll 2: 1
Current score: 22
You lost!
```

Write a Python program to simulate this game.

The first line has been written for you in the answer grid.

Do not write outside the box

The dice rolls are carried out by the program generating random numbers between 1 and 6. You will need to use the Python function `random.randrange(a, b)` which generates a random integer in the range `a` to `b` starting at `a` but finishing one before `b`.

You **should** use indentation as appropriate, meaningful variable name(s) and Python syntax in your answer.

The answer grid below contains vertical lines to help you indent your code.

[11 marks]

```
import random
```

Turn over ►

11

END OF QUESTIONS

Question number	**Additional page, if required. Write the question numbers in the left-hand margin.**

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