P 5 1

Pre-Leaving Certificate Examination, 2021

Computer Science

Sections A & B

Higher Level

Time: 1 hour, 30 minutes

130 marks

Name:
School:
Address:
Class:
Teacher:

Instructions

There are **three** sections in this examination. Section A and B appear in this booklet. Section C is in a separate booklet that will be provided for the computer-based element.

Section A	Short Answer Questions	60 marks	12 questions
Section B	Long Questions	70 marks	3 questions
Section C	Programming	80 marks	1 question

Write your answers for Section A and Section B in the spaces provided in this booklet. There is space for extra work at the end of the booklet. Label any such extra work clearly with the question number and part.

Section A Short Answer Questions 60 marks

Answer **any nine** of the following twelve questions.

Question 1

Rank the following data units from smallest to largest.
Where 1 is the smallest and 4 is the largest.

Size	Ranking
2 Gigabytes	
3000 Kilobytes	
1000 Megabytes	
.5 Terabytes	

Question 2

The Python programming language has a variety of **inbuilt data types**.
Give **one** example of the following data types:

Data Type	Example
Boolean	
Integer	
List	

Question 3

A user wants to display the elements of a list using a print statement. However, when they run the **Python** code the program just outputs the text 'fruit_basket'.

```
fruit_basket = [“apple“, “orange“, “banana“, “kiwi“]
print(“fruit_basket“)
```

Actual output: `fruit_basket`

Desired output: `[“apple“, “orange“, “banana“, “kiwi“]`

Modify the code so the user gets the desired output.

Question 4

What is the **output** of the following piece of Python code:

```
x = 3

while(x<20):
    print(“Number“,x)
    x = x + 3
```

Question 5

(a) Convert the **decimal** number 182 into an 8 bit **binary** number.

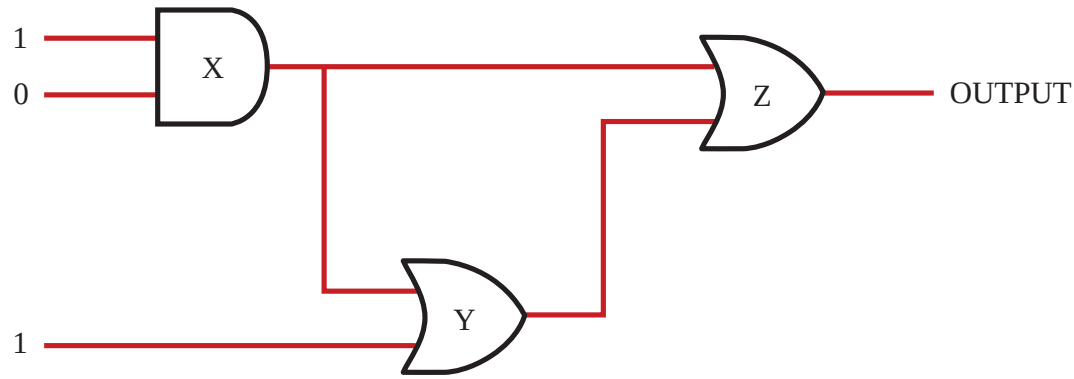
(b) Convert the **binary** bit pattern shown below into **hexadecimal**.

10011000

You should show your workings.

Question 6

Below is an image of a logic circuit.



(a) What type of **logic gate** is labelled **X**?

(b) What type of **logic gate** is labelled **Y**?

(c) What effect does a **not gate** have on its **input**?

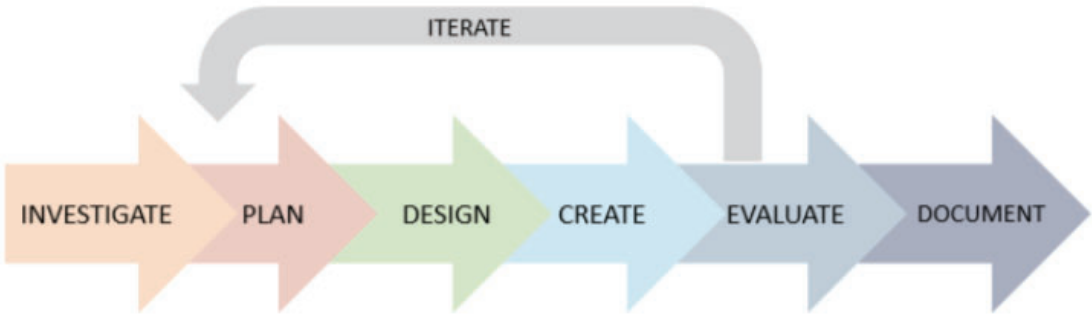
(d) What is the **output** of **Z** with the current inputs?

Question 7

(a) Define what is meant by the term **relational database**.

(b) What name is given to the unique identifier of each row of data in a relational database?

Question 8



The diagram above identifies some of the stages of a **software development design process**. Outline briefly the **main purpose** of the:

(a) Design stage

(b) Evaluate stage

Question 9

Read the following article and answer the questions that follow.

On May 30th 2020, the first crewed orbital spaceflight from American soil since 2011 carried astronauts Bob Behnken and Doug Hurley to the International Space Station.

The Demo-2 mission was the final major test before NASA's Commercial Crew Program certified SpaceX's Crew Dragon capsule for operational, long-duration missions to the space station. As SpaceX's final flight test, it needed to validate all aspects of its crew transportation system, which included the Crew Dragon capsule spacecraft, spacesuits, Falcon 9 launch vehicle, launch pad 39A and other relevant operational capabilities.

While en route to the International Space Station, Behnken and Hurley took control of the Crew Dragon capsule for two manual flight tests. This was to demonstrate their ability to control the spacecraft should an issue with the spacecraft's automated flight systems arise.

During operational missions, the Crew Dragon capsule will be able to launch with as many as four crew members at a time and carry more than 220 pounds of cargo, allowing for an increased number of crew members aboard the space station and increased cargo on board the ISS, meaning that more research in the unique microgravity environment can be investigated. Increased cargo loads on return journeys to Earth also mean that more results and information from experiments on board the ISS can be brought back to Earth.

At the conclusion of the mission to the ISS, Behnken and Hurley boarded the Crew Dragon capsule, which then autonomously undocked and departed the space station, and reentered Earth's atmosphere. Upon splashdown off Florida's Atlantic coast, the crew were picked up by a SpaceX recovery ship and returned to Cape Canaveral.

NASA's Commercial Crew Program is working with SpaceX and Boeing to design, build, test and operate safe, reliable and cost-effective human transportation systems to low-Earth orbit.

(a) Identify **two** ways in which you believe the computer systems on board the Crew Dragon spacecraft make spaceflight safer, more reliable or cost effective.

1.
2.

(b) Outline **one** ethical concern which you believe relates to allowing computer systems autonomously control dangerous tasks such as piloting a spacecraft. How might this concern be overcome?

Question 10

(a) Most general purpose computers share a common architecture named after John von Neumann. **Draw** a diagram of the basic von Neumann computer system architecture, **labelling** the **CPU**, **ALU**, **Control Unit**, **bus**, **memory and input and output devices**.

(b) What is the purpose of the bus system in von Neumann architecture?

Question 11

Abstraction and decomposition are two aspects of computational thinking.

(a) Define what is meant by the term **abstraction**, in the context of computational thinking.

(b) A program is required to enter a set of students' examination grades. The program must also count the number of students who obtained each grade and then output to the user the value of students who achieved each grade. The only valid grades are between the letters A-F. **Explain** how **decomposition** could be used in designing a solution to this problem.

Question 12

The **TCP/IP** protocol is commonly used when transmitting data across the Internet. It consists of four **layers**.

(a) Name and briefly explain the function of **two** of the layers in the TCP/IP protocol.

(b) What is an advantage of layering?

Section B — Long Questions — 70 marks

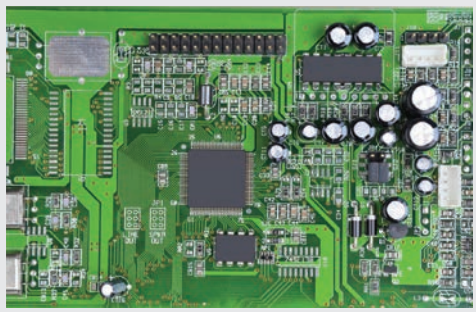
Answer **any two** of the following three questions.

Question 13

Read the following article and answer the questions which follow.

Computer systems have become an integral part of society and have made our lives more comfortable and convenient. From aviation to medical industries, computer systems have a wide range of applications in our society. All of these systems consist of a number of different electronic components that work together to form electronic circuits that control machines and process information.

Electronic circuits are located on **PCBs**. Components on the PCBs control electric current to perform various functions within a computer system such as signal amplification, computation and data transfer. Electronic circuits consist of several different components such as resistors, transistors, capacitors and diodes. These components work together to form the logic circuits that run our society.



(a) **(i)** What does the term **PCB** stand for?

(ii) What is the difference between continuous and discrete data?

(iii) Identify the following data as either being continuous data or discrete data.

Data	Data Type
Height	
Sound volume	
Number of students in a class	
Wind speed	

(b) **(i)** Using the letters A, B, C and D, match each image with the corresponding component in the table below.

			
A	**B**	**C**	**D**

Component	Image
Resistor	
Capacitor	
Transistor	
LED	

(ii) What is an analog signal? Give **two** examples of analog signals you have examined during the course.

(c) A farmer is monitoring his crops that are growing in a greenhouse. To optimise growing conditions, the farmer uses three sensors to monitor the **humidity (H)**, **air temperature (T)** and **soil moisture (M)** within the greenhouse. These sensors provide individual digital inputs to a **window controller logic circuit (w)** which controls the automatic opening and closing of the windows in the greenhouse roof to control the conditions within the greenhouse.

The **window controller (w)** will **give an output signal of 1** to **open** the greenhouse window and the controller will **give an output signal of 0** to **close** the greenhouse window.

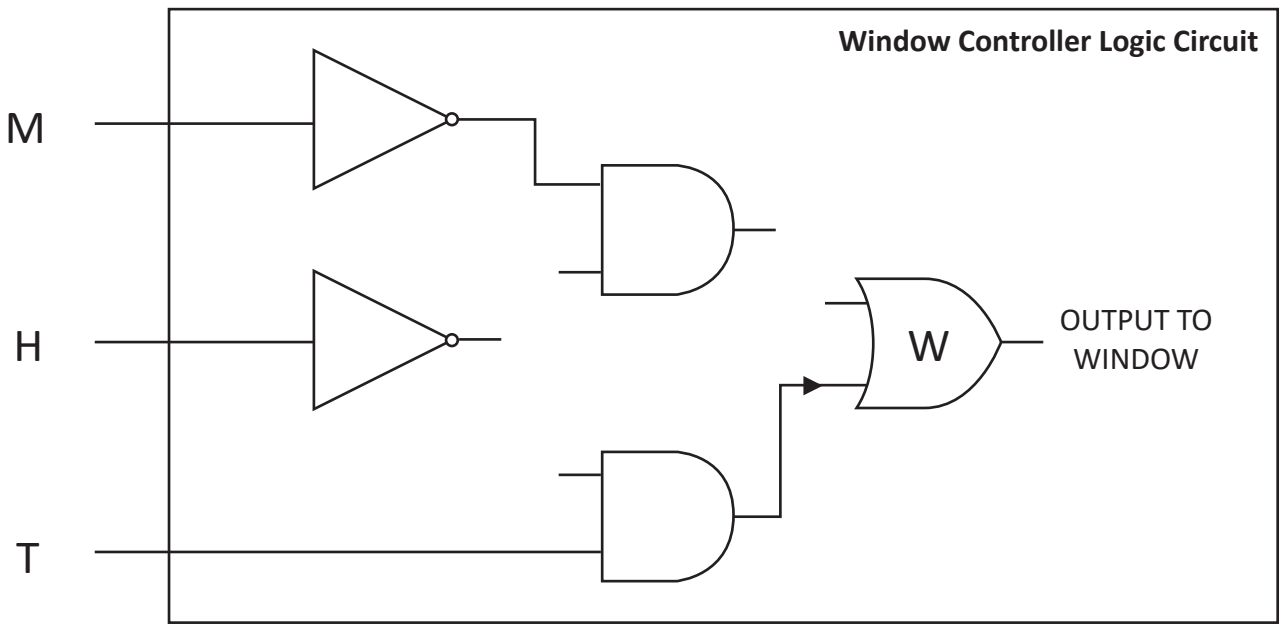
For the window controller **(w)** to give an output of 1 so the window opens it needs **two** of the sensor inputs to meet either one of two conditions:

Condition 1: The humidity is below 40% and the soil moisture is below 5%

Condition 2: The temperature is above 30° and the humidity is above 40%

Complete the following logic circuit so that under either condition 1 or 2 the window controller **(w)** will send an output of 1 to open the window.

Parameter description	Parameter	Sensor input	Condition
Humidity sensor	H	0	< 40%
		1	>= 40%
Air temperature sensor	T	0	< 30°
		1	>= 30°
Soil moisture sensor	M	0	< 5%
		1	>= 5%



Question 14

(a) Mary wants to purchase a new computer and is looking at two different models. The specification of each computer's CPU is shown in the table below.

Computer 1	Computer 2
Base Clock Speed: 3.2Ghz	Base Clock Speed: 3.0Ghz
Cache: 64MB	Cache: 64MB
CPU Cores: 12	CPU Cores: 32
Thermal Design Power (TDU): 105W	Thermal Design Power (TDU): 250W

(i) Mary wants to use the computer for work which involves the editing of large movie files and high-quality images. The salesperson in the store explains that Computer 2 is able to do this faster than Computer 1. Use the information provided in the table above to identify **one** reason for this.

(ii) Identify **two** other components not mentioned in the table above that Mary should consider when comparing the performance of the two computers.

(b) When Mary is questioning the sales rep about the computers' memory, they keep referring to primary and secondary storage.

(i) Explain **two** key **differences** between primary and secondary storage.

(ii) State **two** benefits of Solid State Drives (SSDs) compared to magnetic drives.

(c) Explain the cycle of operations that are carried out during the fetch and execute cycle. The explanation should refer to the role of registers.

Question 15

More than 80 per cent of the TV shows people watch on Netflix are discovered through the platform's recommendation system. That means the majority of what customers decide to watch on Netflix is the result of decisions made by an algorithm. Netflix uses machine learning and algorithms to help break viewers' preconceived notions and suggests shows that customers might not have initially chosen. When any of the over 180 million active users have any interaction with Netflix, its users generate data that Netflix's algorithms can use. With more data, machine learning algorithms perform better, which leads to better customer experiences; better customer experiences drive more customer usage and engagement, which in turn generates more data. Feedback from every visit to the Netflix service continually re-trains the algorithms, allowing them to improve the accuracy of their prediction of what customers are most likely to watch. Customer data and Netflix's algorithms and computation systems continue to feed into each other to produce fresh recommendations to provide customers with a product that brings them joy and constantly returning to the service.

(a) Define the term **algorithm**.

(b) **(i)** Fill in the blank array to show the final form of the array [5, 1, 4, 3, 9], if an **ascending** bubble sort algorithm is applied to it.

Final iteration				

(ii) How many passes through the data in part (i) will be made?

(iii) What would be the maximum number of passes through an array of 100 values?

(c) A programmer at Netflix wants to implement a search algorithm on subscriber viewing numbers. The algorithm that will be used will work on small arrays. An example of a small array is shown below.

Subscriber Viewing Numbers = [1358, 2000, 2850, 3900, 5200, 6700, 8000, 9950, 11679]

(i) Explain how a **linear search algorithm** works and how it would find the integer value 2850 in the Subscriber Viewing Numbers array above.

(ii) What property of the Subscriber Viewing Numbers array means the programmer could use a binary search algorithm to find the position of the integer value 6700?

(iii) For some data, the programmer must search large arrays containing hundreds of values. Which search algorithm should the programmer use if he wants to use the most efficient algorithm? Explain your answer.

(iv) Outline briefly **one** example of how algorithms have played a role in the following areas of society:

Healthcare:

Automotive industry:

Acknowledgements

Q6.
Images sources: www.autodesk.com/products/eagle/blog/you-shall-not-pass-how-logic-gates-work-in-digital-electronics/
Designed with www.circuitverse.org/simulator
Q8. Image from HL sample paper q12
Q9. Sources:www.nasa.gov/press-release/nasa-astronauts-launch-from-america-in-historic-test-flight-of-spacex-crew-dragon/
Q11. Source: www.techterms.com/definition/recursivefunction
Q13. www.autodesk.com/products/eagle/blog/printed-circuit-boards-10000-feet-introduction-electronics-beginners/
Images for (ii) www.ie.rs-online.com/
Q15. www.wired.co.uk/article/how-do-netflixs-algorithms-work-machine-learning-helps-to-predict-what-viewers-will-like#:~:text=Here's%20how%20it%20works.,genres%20to%20make%20-its%20predictions.
www.help.netflix.com/en/node/100639

P 5 2

Pre-Leaving Certificate Examination, 2021

Computer Science

Section C

Higher Level

Time: 1 hour

80 marks

Instructions

There is one section of the examination paper in this booklet.

Section C	Programming	80 marks	1 question

Answer all parts of the question on your digital device.

Instructions are provided for each question.

Ensure that you save your work regularly and when you complete each question.

Do not change the file names or save your work under different file names.

If you are unable to get some code to work correctly you can comment out the code so that you can proceed. The code that has been commented out will be reviewed by the examiner.

Section C Programming 80 marks

Answer all question parts.

Question 16

A school is looking at ways of speeding up and streamlining the exam correcting process for teachers within the school. Currently, teachers within the school use a number of different methods to grade their students and keep track of student progress. The majority of teachers use a percentage style marking system based between (0 - 100%), but parents and students would prefer a letter based grade, either an A, B or C, as they find this form more meaningful. The current grading system must be changed to reflect this.

(a) Open the program called **Question16_A.py** from your device.
Enter your name in the space provided on **Line 2**.

This program is designed to ask the user for the student's name and the mark the student scored on an exam. When the program is run, it outputs the student's name and their result in the traditional percentage style format.

```
1  # Question 16(a)
2  # Student name:
3
4  student_name = input("Please enter the students name: ")
5  student_score = int(input("Please enter the students mark: "))
6  score_as_a_percentage=(student_score/150)*100
7
8
9  print(student_name,"scored",score_as_a_percentage,"%")
```

A sample run of the program is shown below; the student's name is Martin and they scored 75 out of a possible 150 marks.

```
Please enter the students name: Martin
Please enter the students mark out of 150: 75
Martin scored 50.0 %
```

Modify the program to do the following:

(i) Currently the '**student_score**' variable is converted to an integer value. However, the teacher has realised in some cases the students' results may include decimals; for example, a student may score 130.5 out of a 150. Modify the program so it can deal with **float** values.

(ii) Currently the program grades the exam out of a hard coded value of 150. However, not all exams are marked out of 150. Modify the program so that it prompts the user to enter a value called '**exam_total**'. The '**exam_total**' variable should then be used by the program in the calculation of the overall percentage value. The '**exam_total**' input must be an integer value.

Two different sample runs of the program are given below where values of 100 and 200 are used for the '**exam_total**' variable.

```
Please enter the students name: Martin
Please enter the students mark: 50
Please enter the total amount of marks going for the exam: 100
Martin scored 50.0 %
```

```
Please enter the students name: Martin
Please enter the students mark: 50
Please enter the total amount of marks going for the exam: 200
Martin scored 25.0 %
```

(iii) By using the function **round**, or otherwise, modify the program so that the value of the variable 'percentage' is rounded to one decimal place when it is displayed.

When the program is run the output may look as follows:

```
Please enter the students name: Martin
Please enter the students mark: 67
Please enter the total amount of marks going for the exam: 150
Martin scored 44.7 %
```

(iv) Create a general function called '**username**' that asks the user to enter their name. This function should then return the user's chosen name into a welcome message within the program.

Modify the program to **call the function**.
Modify the program to **display a welcome message containing the user's name**.
When the program is run it may look as follows.

```
Please enter your username: Martin
Welcome Martin, to the student result calculator.
```

```
Please enter the students name: Julie
Please enter the students mark: 100
Please enter the total amount of marks going for the exam: 100
```

(v) The teacher uses a percentage style grade when writing their own reports. However, the exam reports that the parents of the students receive show the result as either an A, B or C as students and parents find these types of grades more meaningful.

Extend the program so it displays the student's result as both a percentage and as a letter using the ranges given below.

Grade Range (%)	Grade Category
80 – 100	A
60 – 79	B
0 – 59	C

When the program is run the output may look as follows:

```
Welcome to the student result calculator.
Please enter the students name: Martin
Please enter the students mark: 100
Please enter the total amount of marks going for the exam: 150
Martin scored 66.7 %. They got a B.
```

Save and close your file before moving on to the next part.

[OVER]

(b) Open the program called **Question16_B.py** from your device.
Enter your name in the space provided on **Line 2.**

A teacher has a number of different classes whose exams they must correct. To make it easier to analyse student result data, the teacher uses separate lists to record the names and results of students. The results of one class are shown below in **Table 1**.

Create a program that allows the teacher to enter their students' names and results so they can be analysed for class reports.

Student Name	Student Result (out of 200)
Martin	140
Lucy	100
Paul	78
Julie	185
Sam	45
Mark	124
Maud	178

Table 1

Your program should use a function to ask the user to input the student names until a value of 'end' or 'End' is entered. The program should use a separate function to ask the user to input numeric student exam results until a value of '-1' is entered. Student names and student exam results should both be stored in separate lists.

After all the names and results have been entered, the program should display the inputted student names and results to the user.

As the teacher has a large number of students and results to enter, the program should be able to tell the user if the number of student names entered does not match the number of student results entered. If this happens, the program should allow the user to enter the missing student name(s) or result(s) at the correct index location according to Table 1.

For their personal reports the teacher needs to analyse the data to find:

- Highest score as a percentage of 200 marks.
- Lowest score as a percentage of 200 marks.
- Average score as a percentage of 200 marks.

Score as percentage can be calculated by:

$$\% = \left(\frac{\text{StudentResult}}{200} \right) \times 100$$

Your program should output this data to the user.

Your program may look as follows:

```
Please enter the students name and enter ‘end’ or ‘End’ when complete: Martin
Please enter the students name and enter ‘end’ or ‘End’ when complete: Lucy
Please enter the students name and enter ‘end’ or ‘End’ when complete: Paul
Please enter the students name and enter ‘end’ or ‘End’ when complete: Julie
Please enter the students name and enter ‘end’ or ‘End’ when complete: Sam
Please enter the students name and enter ‘end’ or ‘End’ when complete: Mark
Please enter the students name and enter ‘end’ or ‘End’ when complete: Maud
Please enter the students name and enter ‘end’ or ‘End’ when complete: end

Please enter the students result and enter ‘-1’ when complete: 140
Please enter the students result and enter ‘-1’ when complete: 100
Please enter the students result and enter ‘-1’ when complete: 78
Please enter the students result and enter ‘-1’ when complete: 185
Please enter the students result and enter ‘-1’ when complete: 45
Please enter the students result and enter ‘-1’ when complete: 124
Please enter the students result and enter ‘-1’ when complete: 178
Please enter the students result and enter ‘-1’ when complete: -1

Student names are: [‘Martin’, ‘Lucy’, ‘Paul’, ‘Julie’, ‘Sam’, ‘Mark’, ‘Maud’]
Student results are : [140.0, 100.0, 78.0, 185.0, 45.0, 124.0, 178.0]

Highest value scored is: 92.5 %
Lowest value scored is : 22.5 %

The student who scored the highest value is: Julie
The student who scored the lowest value is: Sam
The average value in the class is : 60.7 %
```

OR

```
Please enter the students name and enter ‘end’ or ‘End’ when complete: Martin
Please enter the students name and enter ‘end’ or ‘End’ when complete: Lucy
Please enter the students name and enter ‘end’ or ‘End’ when complete: Paul
Please enter the students name and enter ‘end’ or ‘End’ when complete: Julie
Please enter the students name and enter ‘end’ or ‘End’ when complete: Sam
Please enter the students name and enter ‘end’ or ‘End’ when complete: Mark
Please enter the students name and enter ‘end’ or ‘End’ when complete: Maud
Please enter the students name and enter ‘end’ or ‘End’ when complete: end

Please enter the students result and enter ‘-1’ when complete: 140
Please enter the students result and enter ‘-1’ when complete: 100
Please enter the students result and enter ‘-1’ when complete: 78
Please enter the students result and enter ‘-1’ when complete: 185
Please enter the students result and enter ‘-1’ when complete: 45
Please enter the students result and enter ‘-1’ when complete: 124
Please enter the students result and enter ‘-1’ when complete: 178
Please enter the students result and enter ‘-1’ when complete: -1

Student names are: [‘Martin’, ‘Lucy’, ‘Paul’, ‘Julie’, ‘Mark’, ‘Maud’]
Student results are: [140.0, 100.0, 78.0, 185.0, 45.0, 124.0, 178.0]

ERROR: You have entered more student results than student names
Compare the entered names and results and add the missing name to the correct index location

Student results are: [140.0, 100.0, 78.0, 185.0, 45.0, 124.0, 178.0]

Student names are: [‘Martin’, ‘Lucy’, ‘Paul’, ‘Julie’, ‘Mark’, ‘Maud’]

Please enter the students name that was left out: Sam
What is the index position of the name: 4

Highest value scored is: 92.5 %
Lowest value scored is: 22.5 %

The student who scored the highest value is: Julie
The student who scored the lowest value is: Sam
The average value in the class is: 60.7 %
```

Blank Page