



COMPUTER SCIENCE

HIGHER & ORDINARY LEVEL

MARKING SCHEME

Pre-Leaving Certificate Examination 2024

Higher Level: page 2

Ordinary Level: page 18



Section A

45 marks

Answer any nine questions. Each question carries 5 marks.

Question 1

Please study the code carefully and then answer the following question: Given the following six lines of code from a program, for each line, fill in the value stored in the variable answer.

```

1 answer = 7
2 name = "Robin"
3 answer += 1
4 name = answer
5 answer = "Charlie"
6 answer = name

```

Lines of Python code	Value stored in "answer" at each line
answer = 7	7
name ="Robin"	7
answer += 1	8
name = answer	8
answer = "Charlie"	"Charlie"
answer = name	8

*(Note) - 5 marks, best 5 count. 0 if incorrect.

Question 2

Briefly describe one problem that can be solved using heuristics and why it needed a heuristic approach to be solved.

Sample Answer, not required, red components are the marking scheme.

Consider yourself a salesperson that must visit multiple places before returning home. You must determine the fastest path in order to save time and money. The "Travelling Salesman Problem" (TSP) is an example of this problem and it is heuristic. Because there are so many potential routes to take when there are several cities to visit, it is necessary to use a heuristic technique because doing so would take a long time.

Heuristic methods are intelligent ways that quickly identify a reasonably short route, even if it isn't really the shortest route possible. When there are numerous cities to visit, these techniques are crucial for effectively resolving TSP and difficulties of a similar nature. Sat navigation could have also been used.

3 marks for why (Fair description - limited understanding = 1 mark)

2 marks for reasonable example (Fair description - limited understanding = 1 mark)

Question 3

The following code was intended to replace any negative numbers in a list with the value 0.

```
1 myList = [1, 2, 3, 4, -5, 6]
2
3 for item in myList:
4     if item < 0:
5         item = 0
6
7 print (myList)
```

However, the above code does not work as intended, printing out the result: [1, 2, 3, 4, -5, 6]

Explain why the code did not work as intended.

The reason for this issue/bug is that item is a variable assigned for the loop iterations (for loop). Each list item is copied into this variable (item), and when a <0 value is identified it is then modified. However, the variable item is modified and not the actual list. When you then print the list the same values are presented.

2 marks for mentioning the variable item (Fair description - limited understanding = 1 mark)

3 marks for why this occurred, as in the variable was assigned the change, and not the element in the list (Fair description - limited understanding = 1 mark)

Question 4

Testing is used in software development. The below code was intended to replace any negative numbers in a list with the value 0, but instead it outputs [1, 2, 3, 4, -5, 6], not changing the negative values as intended.

```
1 myList = [1, 2, 3, 4, -5, 6]
2
3 for item in myList:
4     if item < 0:
5         item = 0
6
7 print (myList)
```

Explain how you might test the above code to identify the errors in the program.

Mention an appropriate test, for example, use case or even a unit test (you can ignore if they leave out it should be a function). **2 marks**

Explanation of the test process selected

3 marks (Fair description - limited understanding = 1 mark)

Question 5

Describe what a unit test is, and how it differs from a system test.

Individual components or modules of a software program are verified separately during a unit test. A unit test's objective is to verify that each module or component of the software performs as intended. The smallest tested component of the code, such as a function, is referred to as a "unit" in this context. These are more often than not automated.

**3 marks must include small unit and automated
(Fair description - limited understanding = 1 mark)**

System tests, on the other hand, evaluate the behaviour of the entire software system as a whole. These tests verify that all the components of the system work together correctly to deliver the expected functionality.

**2 marks must include user and overall system
(Fair description - limited understanding = 1 mark)**

Question 6

The list below contains 100,000 integers. Only the first six items in the list are shown.

```
myList = [1, 2, 3, 4, -5, 6, ...]
```

- (a) **Why would you not present the data in the above form to someone that wants to find the number of items in the list that are negative?**

Data in the above format as above is not readable by humans, for example, if you were to see how many negative numbers in the 100,000 in a file you would not be able to, it would be too hard for humans to read.

**3 marks must include size and non interpretability
(Fair description - limited understanding = 1 mark)**

- (b) **Name one graphical form that would be suitable for presenting the data in the list, and one graphical form that would be unsuitable and why (for each form).**

A bar graph would be suitable (or pie chart).
A line graph could be unsuitable

2 marks one for each (Fair description - limited understanding = 1 mark)

Question 7

Below is the code of a sorting algorithm:

```
myList = [9, 10, 30, 19, 3]

for index in range(1, len(myList)):
    itemToInsert = myList[index]
    position = index
    while position > 0 and myList[position-1] > itemToInsert:
        myList[position] = myList[position-1]
        myList[position-1] = itemToInsert
        position -= 1
```

(a) Name the sorting algorithm.

Insertion sort

3 marks (similar algorithm such as bubble sort = 1 mark for attempt)

(b) What is the time complexity for the worst-case scenario for this algorithm?

$O(n^2)$

**2 marks must include N^2 but does not need O
(Fair description - limited understanding = 1 mark)**

Question 8

Agent based modelling is an effective modelling tool for certain scenarios.

(a) Name a scenario that agent-based modelling can be used for.

Agent based modelling can be used to mimic and understand how traffic works in cities. In this case, every car or person is like a little computer character with its own traits and actions. These characters can talk to each other and react to things like traffic lights, road closures, and anything else that can make traffic better or worse.

2 marks any example is okay (Fair description - limited understanding = 1 mark)

(b) Explain the benefits of using agent-based modelling for your example named above.

Agent-based modelling allows users to gain insights into traffic congestion, the impact of new road infrastructure, and strategies for optimising traffic management.

3 marks any two benefits (Fair description - limited understanding = 1 mark)

Question 9

Below are two relational tables in a database.

ID	FName	SName	Year
1	Keith	Quille	1
2	Roisin	Faherty	2
3	Karen	Nolan	3

Year_Tutors

ID	Year_Tutor_ID	FName	SName
1	3	Charlie	Quille
2	2	Robin	Quille

Students

Describe the relational relationship between the tables above.

Table 1 represents teachers and tutors, table 2 represents students. Each table has a primary key.

2 marks description of each table - could be part of overall answer

(Fair description - limited understanding = 1 mark)

Table 1 to table 2 are relational, that is, a year tutor is related to/has students. This is represented by the foreign key field "Year_Tutor_ID", for example, Robin Quille has Roisin Faherty as her year tutor.

3 marks linking primary and foreign keys to describe one to many relationship - does not need to include the words one to many (Fair description - limited understanding = 1 mark)

Question 10

Below is an extract from a US National Cancer Institute post titled 'Can Artificial Intelligence Help See Cancer in New, and Better, Ways?' (2022). Read the extract carefully and answer the question that follows.

"Two identical black-and-white pictures of murky shapes sit side-by-side on a computer screen. On the left side, Ismail Baris Turkbey, M.D., a radiologist with 15 years of experience, has outlined an area where the fuzzy shapes represent what he believes is a creeping, growing prostate cancer. On the other side of the screen, an artificial intelligence (AI) computer program has done the same —and the results are nearly identical."

Name and describe one ethical consideration and proposed action that you think should be applied if we are to use AI in the medical domain for predicting cancer.

When we use AI to predict cancer in medicine, we need to worry about two important things (any one discussion is okay):

Reliability: We want the AI to be good at making predictions, so it doesn't give the wrong diagnosis or advice.

Fairness: The AI should treat everyone the same way. If it's biased and gives different results to different groups of people, it can create unfair healthcare differences.

2 marks any reasonable ethical issue (Fair description - limited understanding = 1 mark)

One proposed action is to always have humans on the loop, that is, for every prediction there should be some human oversight to ensure fairness and reliability.

3 must be related to the ethical consideration (Fair description - limited understanding = 1 mark)

Question 11

Websites are typically not as adaptive as they should be to allow for inclusive use for users with special/additional needs. Name and describe two elements or design features that you would implement in a website to support users with additional needs.

Text to speech and speech to text: Functionality can be a huge help to users who have hearing or vision problems. TTS technology speaks aloud the website's text content so that users who are blind can access and comprehend the content. STT, on the other hand, transforms spoken words into written text, making it possible for people with hearing loss to utilise the website.

3 marks any reasonable element/design feature
(Fair description - limited understanding = 1 mark)

A website will adjust to different devices and user needs if it has a responsive and accessible design. Users who utilise assistive devices or who have cognitive or mobility problems must understand this. To accommodate various screen sizes and input methods (mouse, keyboard, touch, and voice), elements should be correctly scaled, spaced, and arranged.

2 marks any reasonable element/design feature
(Fair description - limited understanding = 1 mark)

Question 12

The below code uses the mean function from the statistics module to find the mean in a list:

```
myList = [1, 2, 3, 4, 5]
median = statistics.mean(myList)
print(median)
```

Pattern recognition is the ability to recognise common approaches (such as code) or patterns within problems you are trying to solve. When you break down (decompose) a problem into smaller subproblems, you may be able to spot patterns/previous code approaches that will help you to solve the problem. – adopted from Isaac Computer Science.

Identify one pattern and explain its use if you were to write the code for the statistics.mean function yourself:

One pattern that would be used to solve this problem to get the mean is a loop to add up all of the values.

This loop allows us to get the total of all the numbers in the list (a key component of getting the mean).

3 marks any of the two patterns (Fair description - limited understanding = 1 mark)
2 marks explain its role (Fair description - limited understanding = 1 mark)

Section B

Long Questions

78 marks

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

Question 13

39 marks (7, 15, 17)

(a) What is a recursive algorithm?

A recursive algorithm breaks down a complicated problem into smaller, related problems and solves each of them in a similar fashion.

3 marks for mentioning smaller parts (Fair description - limited understanding = 1 mark)

4 marks for mentioning smaller parts are similar and overall definition

(Fair description - limited understanding = 2 marks)

(b) Recursion is slower computationally than solving the same problem using a loop, yet recursion is often the preferred method over a loop for some algorithms such as the quicksort algorithm, why is this the case?

Two examples are:

Code clarity and reading: When used to solve issues that naturally display recursive behaviour, recursive algorithms can occasionally result in more succinct and understandable code. For algorithms like quicksort, the code can closely resemble the problem's intrinsic structure, making it simpler to comprehend and maintain. Quicksort breaks down a problem into smaller sub-problems and solves them recursively.

Similarity to the problem: Recursion can be similar with a problem's natural structure in some cases. The divide-and-conquer paradigm, on which Quicksort is built, divides the problem into smaller subproblems, and this decomposition naturally lends itself to recursion.

7 marks for any one reason (Fair description - limited understanding = 2 marks)

8 marks for a deeper understanding of it, for example, readability or similar to how quicksort works (Fair description - limited understanding = 2 marks)

- (c) Below is an example of a recursive function for the quicksort algorithm. This algorithm sorts a list in ascending order. Modify the code to sort the list in descending order. The first four rows are completed where no modifications were needed.

Original code	Modified code – leave blank if modification is not needed.
<code>def qS(listIn):</code>	-
<code> if len(listIn) > 1:</code>	-
<code> pivot = listIn[-1]</code>	-
<code> belowPiv = []</code>	-
<code> for item in listIn[:-1]:</code>	-
<code> if item < pivot:</code>	If item > pivot
<code> belowPiv.append(item)</code>	-
<code> abovePiv = []</code>	-
<code> for item in listIn[:-1]:</code>	-
<code> if item > pivot:</code>	If item < pivot
<code> abovePiv.append(item)</code>	-
<code> return qS(belowPiv) + [pivot] +</code>	-
<code> qS(abovePiv)</code>	-
<code> else:</code>	-
<code> return(listIn)</code>	-

8 marks for first correct line

8 marks for second correct line

+1 mark for both right with no errors

Question 14

39 marks (6,11,10,12)

- (a) The internet allows the world wide web to run on it. This happens in part due to communication protocols. One such set of protocols that is widely used is TCP/IP.

Explain what TCP is in the transport layer in the TCP/IP protocol stack.

TCP is a standard communication protocol that ensures the reliable and ordered delivery of data between devices on a network. It establishes a connection before data transfer, manages the flow of data, and performs error checking to ensure that the information sent from one device is received accurately by the destination device. TCP is part of the TCP/IP protocol suite, which forms the basis for communication on the internet.

**6 marks based on any definition of the TCP protocol
(Fair description - limited understanding = 2 marks)**

- (b) IP addresses are used in the internet layer of the TCP/IP protocol stack. The following is an example of an IP address:

192.168.0.1

- (i) What is an IP address?
(ii) As the number of devices connected to the internet grows, identify one issue that could arise with an IPv4 address as shown above?

An IP address is like a digital ID for devices on the internet, helping them talk to each other. The worry with IPv4 addresses is that there aren't enough of them for all the new gadgets we're connecting. That's why there's a switch to IPv6, which has a lot more addresses, making sure everything stays connected as we add more devices to the internet.

5 marks for defining an IP address (Fair description - limited understanding = 2 marks)

6 marks for the limitation of the number, IPv6 not needed

(Fair description - limited understanding = 2 marks)

- (c) An IP address is often used when cybercrime is investigated. This is part of the TCP/IP stack. How can an IP address be used in cybercrime investigations?

When investigators are trying to catch cybercriminals, they use something called an IP address. It's like a digital ID for devices on the internet. In the tech world, it's part of the TCP/IP stack, and it helps figure out where online activities are coming from and going to. So, if someone's up to no good online, the investigators can use the IP address to track them down and find out who they are and where they're doing their activities.

5 marks for the concept that they are traceable/like an ID

(Fair description - limited understanding = 2 marks)

5 marks for any reason that may aid in cybersecurity

(Fair description - limited understanding = 2 marks)

- (d) Interactive information systems are often implemented as a client server model. With respect to data security, why is a client server model a good choice?

For interactive information systems, using a client-server model is a wise decision for data security because it comes with a number of benefits:

- It enables unified management of security and makes it simpler to enact regulations and safety measures.
- Access Control: The server can limit who has access to data, ensuring that only people with permission can access it.
- Data exchanged between clients and servers can be encrypted to ensure its security while in transit.
- User Verification: Servers can verify a user's identity and determine if they are authorized to view a certain piece of data.
- Logging: Servers can preserve thorough records of user behavior that can be used to track and look into security concerns.

6 marks for any one concept for data security

(Fair description - limited understanding = 2 marks)

6 marks for any second concept for data security

(Fair description - limited understanding = 2 marks)

Question 15

39 marks (4,12,12,11)

(a) What is the difference between raw data and data transformed for analysis?

Raw data

Unorganised and unprocessed data is referred to as “raw data.” It is the most fundamental type of data and is meaningless on its own. Various formats for raw data exist, including those for numbers, text, pictures, and other data types. Examples of raw data include a list of numbers, a collection of sensor readings, or a string of characters and words in a text file.

2 marks (Fair description - limited understanding = 1 mark)

Transformed data

Raw data is made usable and valuable for decision-making, comprehension, or communication by providing context, relevance, and structure. In order to make information easier to understand and use, it is frequently transformed, this may include, fixing problematic data, taking the raw data and calculating frequencies of occurrence for a bar chart etc.

2 marks, should include one example of transformed data (Fair description - limited understanding = 1 mark)

(b) The World Anti-Doping Agency (WADA) state that “Blood doping is the misuse of certain techniques and/or substances to increase one’s red blood cell mass, which allows the body to transport more oxygen to muscles and therefore increase stamina and performance.”

Each year, athletes are tested for increased red blood cells, where the data presented in the following histogram shows the red blood cell count on the X axis and the number of athletes on the Y axis.

Do you think that some athletes were blood doping? Analyse the histogram and available data (mean, mode and median) to support your answer.

There is likely some blood doping going on. The graph is mostly symmetrical (normal distribution) as the mean, mode and median are similar (students do not need to prove this). There are a group 1-3 people who have a distinctly different red blood cell count, outside of this distribution, and they have a red blood cell count of ~ 6.5.

4 marks for providing analysis on histogram

(Fair description - limited understanding = 2 marks)

4 marks for using mean, median and mode

(Fair description - limited understanding = 2 marks)

4 marks for bringing together the two previous sets of marks to make a decision

(Fair description - limited understanding 1 mark)

- (c) WADA would like you to develop an algorithm that automatically detects if blood doping occurs based on red blood cell count. By examining the histogram in the Figure from part b of this question, write an algorithm in pseudocode that will detect athletes are blood doping assuming that the red blood cell counts are stored in a list such as the one below (note: the data is in a one dimensional list, call `athletes_RBCB` that you can reference):

List example:

```
athletes_RBCB = [4,5.6,4.2, 6.6, 6.4, 4,1]
```

Hint: Loop through the list and write the pseudo code to identify any possible values that may have blood doped.

Read in `athletes_RBCB` as 1d list and same as `athletes_RBCB`

Iterate through `athletes_RBCB`: (for each `rbc` in `athletes_RBCB` :)

If `rbc > 6.25`:

Output -> blood doping may have occurred

Else:

Output -> blood doping may not occurred

4 marks for reading in list (Fair description - limited understanding = 2 marks)

4 marks for looping through and checking (Fair description - limited understanding = 2 marks)

4 marks for conditional value and output (> 6.1-6.5 would be acceptable) (Fair description - limited understanding = 2 marks)

- (d) False predictions are often made by such algorithms. A False Positive (FP) is where an athlete that is predicted as blood doping but did not, and a False Negative (FN) is where an athlete is predicted as not blood doping but was. Briefly describe, basing your answer on ethics, which of the above predictions (a False Positive or a False Negative) is worse for the WADA.

The least desirable error for the World Anti-Doping Agency (WADA) would be a False Negative (FN). A False Negative happens when an athlete is expected to not be blood doping but is actually blood doping in the context of WADA's aim to detect and prohibit doping in sports. False Negatives are typically viewed as more harmful in the context of anti-doping efforts because they allow doping to go undetected and undermine the fundamental principles of fair play in sports. False Positives (FPs) are also problematic because they can unjustly damage an athlete's reputation, trigger investigations, and potentially harm their career.

3 marks for showing understanding of the meanings of FN and FP (Fair description - limited understanding 2 mark)

5 marks for comparing and selecting which one and why (Fair description - limited understanding 2 mark)

3 marks for why not FP or at least why it is the lesser of the two negative outcomes (> 6.1-6.5 would be acceptable) (Fair description - limited understanding = 2 marks)

Section C

Programming

87 marks

Answer all question parts.

Question 16

(43 marks)

- (a) Surveys are common practice, and analysis of such surveys is often essential to gain an understanding of data collected, transforming it into information. This survey was data collected by asking people the county they were from and their monthly rent. This was to determine national and country average rent rates. This survey only included people from Dublin, Kildare and Laois.

Open the program called Question16_A.py from your device.

Enter your name on line 2.

```
# Enter name:

county = ["Dublin", "Laois", "Dublin", "Dublin", "Dublin", "Dublin",
"Dublin", "Kildare", "Laois", "Kildare", "Dublin", "Laois", "Dublin"]

rent = [2500, 1200, 2000, 2100, 1900, 1999, 1790, 1500, 1000, 1390, 1980,
1105, 1999]

# Part i

# Part ii

print("-"*18)
print("{:<12}".format("County")+":<12}".format("Rent €"))
print("-"*18)
for index in range(len(county)):
    print("{:<12}".format(county[index])+":<12}".format(rent[index]))

# Part iii

# Part iv
```

This way the data is stored is that each index (0, 1, 2 ...) in each of the two lists (county and rent) holds corresponding data. That is the first element of each list is a response from the same person. The list county records their county and the list rent records how much their monthly rent is. For any analysis in this question, you must assume that the lists could be larger, so you must calculate all values using code, they must not be hard coded.

The program currently loops through the list and prints to the screen each survey response:

```
-----
County    Rent €
-----
Dublin    2500
Laois     1200
Dublin    2000
```

Modify the program to do the following:

- (i) Where Part i is a comment in the code, write code to calculate and print the total number of survey responses that the study has collected. When the program is run, it may look as follows:

```
The total people in the survey is: 13
```

```
print("The total people in the survey is:", len(county))
```

2 marks (1 mark for determining the length and 1 for printing)

- (ii) Where Part ii is a comment in the code, write code to take in and store another survey response from the user, you must take in their county name and monthly rent and add them to the appropriate lists. You can assume that the user will always enter one of the following counties (in the correct case, that is, first letter uppercase and the rest lower case) Dublin, Kildare and Laois. When the program is run, it may look as follows:

```
Please enter your county: Laois
Please enter your monthly rent amount: 2000
```

```
surveyCounty = input("Please enter your county:")
surveyRent = int(input("Please enter your monthly rent amount:"))

county.append(surveyCounty)
rent.append(surveyRent)
```

10 marks (3 marks for each entry and variable type, and 2 marks each for appending to the correct lists)

- (iii) Where Part iii is a comment in the code, write code to calculate and print the average rent across all three counties (rounding to two decimal places).

```
averageRent = sum of the values / number of values.
```

When the program is run, it may look as follows:

```
Average Rent for all counties: € 1747.36
```

```
averageRentAll = sum(rent) / len(rent)
print("\n\n")
print("Average Rent for all counties: €", round(averageRentAll,2))
```

10 marks (6 marks for calculating the average rent, 4 marks for printing)

- (iv) Where Part iv is a comment in the code, write code to calculate and print the average rent for each of the three counties Dublin, Kildare and Laois (rounding to two decimal places). When the program is run, it may look as follows:

```
Average Rent for Dublin: € 2033.5
Average Rent for Kildare: € 1445.0
Average Rent for Laois: € 1326.25
```

```
dublinRents = []
kildareRents = []
laoisRents = []

for index in range(len(county)):
    if county[index] == "Dublin":
        dublinRents.append(rent[index])

    if county[index] == "Kildare":
        kildareRents.append(rent[index])

    if county[index] == "Laois":
        laoisRents.append(rent[index])

print("\n")
# Dublin
averageRentDublin = sum(dublinRents) / len(dublinRents)
print("Average Rent for Dublin: €", round(averageRentDublin,2))

# Kildare
averageRentKildare = sum(kildareRents) / len(kildareRents)
print("Average Rent for Kildare: €", round(averageRentKildare,2))

# Laois
averageRentLaois = sum(laoisRents) / len(laoisRents)
print("Average Rent for Laois: €", round(averageRentLaois,2))
```

21 marks (7 marks per average broken into: 4 marks for getting totals, 2 marks for calculating the average (using length in this example) and 1 mark for printing)

Note: this was one example of determining the average rent for each of the three counties, other methods applicable, 7 marks per county applies.

Question 16

(42 marks)

- (b) The infinite monkey theorem states that a monkey hitting keys at random on a typewriter keyboard for an infinite amount of time will almost surely type any given text, including the complete works of William Shakespeare.
Open the program called Question16_B.py from your device.
Enter your name on line 2.

```
# Enter name:

import random

targetWord = "T"

def monkeys_typing():
    guessNumber = random.randint(65, 90)
    letter1 = chr(guessNumber)
    count = 1
    guess = letter1
    print(guess)

    while guess != targetWord:
        guessNumber = random.randint(65, 90)
        letter1 = chr(guessNumber)
        guess = letter1
        print(guess)
        count +=1
    return count

print(monkeys_typing())
```

This `monkeys_typing` function is designed to return the number of times it takes a monkey to guess characters (mimicking the infinite monkey theorem for a limited amount of text) until it guesses the letter T. Please note the random number guesses the ASCII range for upper case letters, and converts them to characters to compare against the desired output, the letter T.

Modify the program to do the following:

- (i) For this part, do not modify the function, modify the main body code to run the function three times and get an average of how many guesses are needed to type the letter T. An example output would be:

Average number of guesses for three runs is: 107.33

```
run1 = monkeys_typing()
run2 = monkeys_typing()
run3 = monkeys_typing()

average = (run1+run2+run3) / 3
print("Average number of guesses for three runs are:", average)
```

22 marks broken into:

- 10 marks for each of the three guesses (not this could be done using a list)
- 6 marks for calculating the average (2 marks each)
- 6 marks for printing

- (ii) **Modify the function to identify how many guess it may take to generate the word “THE”, note you will also have to modify the variable: targetWord = “THE”. An example output would be:**

Average number of guesses for three runs is: 18148.0

```
import random

targetWord = "THE"

def monkeys_typing():
    guessNumber = random.randint(65, 90)
    letter1 = chr(guessNumber)
    guessNumber = random.randint(65, 90)
    letter2 = chr(guessNumber)
    guessNumber = random.randint(65, 90)
    letter3 = chr(guessNumber)
    count = 1
    guess = letter1+letter2+letter3
    print(guess)

    while guess != targetWord:
        guessNumber = random.randint(65, 90)
        letter1 = chr(guessNumber)
        guessNumber = random.randint(65, 90)
        letter2 = chr(guessNumber)
        guessNumber = random.randint(65, 90)
        letter3 = chr(guessNumber)
        guess = letter1+letter2+letter3
        print(guess)
        count +=1

    return count

run1 = monkeys_typing()
run2 = monkeys_typing()
run3 = monkeys_typing()

average = (run1+run2+run3) / 3
print("Average number of guesses for three runs are:", average)
```

20 marks (10 for the three guesses, 10 for combining and comparing).

Section A - Short Answer Questions - 45 marks

Answer any nine questions.

Question 1 - 5 marks

Name and briefly describe any two important developments in computer science over the past 100 years.

Development 1

World Wide Web (1990+) The World Wide Web and the advent of protocols like TCP/IP in the 1990s helped make the internet accessible to the general public as it developed throughout the years. Since then, the internet has transformed practically every aspect of modern life, including communication, commerce, education, and government. It is now an essential component of the 21st century.

3 marks for reasonable example (Fair description - limited understanding = 1 mark)

Development 2

AI: Robotics and machine learning are two examples of AI technologies that have the potential to automate labor-intensive, repetitive operations in a variety of industries. Better production, lower costs, and better efficiency can result from this automation. It enables companies and organizations to do things more quickly and with fewer mistakes.

2 marks for reasonable example (Fair description - limited understanding = 1 mark)

Question 2 - 5 marks

Originally, the staged (or waterfall) development process was used, but over the recent years, developers moved to the iterative development process. Name and describe one reason why developers might prefer the iterative development process.

Many times, software developers prefer the iterative process to the traditional waterfall approach. Iterative development involves building the program piece by piece so that changes can be made in response to what is discovered as they go. When the project's needs are still unclear or continually changing, this is incredibly helpful.

2 marks for naming one, like changing needs

(Fair description - limited understanding = 1 mark)

3 marks for description and why (Fair description - limited understanding = 1 mark)

Question 3 - 5 marks

Integers and Floats are two types of variables used in many programming languages such as Python.

- (a) Provide an example of an integer value, and say where in a programming problem that you have completed you would use an integer.

Example: 12

Where: taking in the age of a user in a program

3 marks for reasonable example and where (Fair description - limited understanding = 1 mark)

- (b) Provide an example of a Float value, and say where in a programming problem that you have completed you would use an integer.

Example: 3.14

Where: Calculating the volume of a sphere, where Pi for example might be used.

2 marks for reasonable example and where (Fair description - limited understanding = 1 mark)

Question 4 - 5 marks

The below program takes in a person's age and stores it in the variable age, it then prints out A, B or C, depending on the value entered for the person's age.

```

1 age = int(input("Please enter your age:"))
2 if age > 16:
3     print("A")
4 elif age < 16:
5     print("B")
6 else:
7     print("C")

```

Given 5 inputs, write into the corresponding box the value that the program will print (that is, A, B or C).

Value entered for age	Output (A, B, or C)
18	A
-1	B
100	A
16	C
3	B

1 mark each

Question 5 - 5 marks

Computational thinking often uses pattern recognition. Pattern recognition is the ability to recognise common previously used code or patterns within problems you are trying to solve. When you break down (decompose) a problem into smaller subproblems, you may be able to spot previously used code/patterns that will help you to solve the problem. – adapted from Isaac Computer Science.

You need to find something behind one of the locked doors, so you need to develop an algorithm to do so (to search), but you can only open one door at a time as all of the keys are on a single bunch of keys that can not be split.

- (a) Name a searching algorithm that could be used for this problem.

Linear search

2 marks for algorithm there is no sorting so binary search is not appropriate (Fair description - limited understanding = 1 mark)

- (b) Name one piece of code and one variable that you may need for your algorithm, and explain your choice for each.

You might use a loop to iteratively start at the LHS and check each door until you reach the RHS. The variable is the key (the value or in this case item that you are looking for).

1 marks for reasonable example of variable (search key)

(Fair description - limited understanding = 1 mark)

2 marks for reasonable example of loop (Fair description - limited understanding = 1 mark)

Question 6 - 5 marks

The diagram to the right, is of an embedded system. This is a Micro:bit but there are also others such as the Raspberry Pi or the Arduino.

- (a) Briefly describe where you have used an embedded system before, mentioning the problem that you were solving with it.

I have used the embedded system (Micro:bit) before when automating a window (using a servo motor) to open and close when the temperature gets to hot or too cold.

3 marks for reasonable example and where (Fair description - limited understanding = 1 mark)

- (b) The user wants to develop a system to take in input from a user via a keyboard, would the embedded system from part a) be suitable for this problem and why?

As part of an ALT I had to store data for a problem student records in a CSV file, the Micro:bit, the Micro:bit could not take in inputs (no keyboard) and did not have enough memory to store the large amount of data.

2 marks for reasonable example and where (Fair description - limited understanding = 1 mark)

Question 7 - 5 marks

Researchers at MIT (Massachusetts Institute of Technology) fooled Artificial Intelligence (AI) into thinking that an image of guns was in fact an image of a helicopter. This fooling of AI is often called AI hacking.

- (a) Given that AI can be hacked, describe one risk for an airport looking to use this AI as the only security to identify anyone bringing in guns to the airport.

If an airport depends only on AI for security, there's a big problem. People can trick the AI by making dangerous things look harmless. They might change a gun to look like something else so the AI can't tell it's a threat. If the airport doesn't have other security measures or people checking, this could be a big danger. So, airports should not rely only on AI because it can be fooled, and they should have backup plans to keep everyone safe.

3 marks for reasonable risk (Fair description - limited understanding = 1 mark)

- (b) Describe one additional action that you would suggest to the airport to address this risk?

Add additional security measures like people on security.

2 marks for reasonable action, like people on the loop (Fair description - limited understanding = 1 mark)

Question 8 - 5 marks

ChatGPT is called generative AI; this is an AI tool that can produce text, maths, programming code and much more. Even Snapchat has generative AI built in now (using ChatGPT) called MyAI, that can answer questions and have conversations.

- (a) Suggest one issue with the use of ChatGPT, My AI or an generative AI.

One problem with using AI like ChatGPT is that it can sometimes produce biased or inappropriate content. This happens because it learns from a lot of text on the internet, which might contain biased or rude content. So, the AI might say things that are not nice or not fair.

3 marks for reasonable issue (Fair description - limited understanding = 1 mark)

- (b) Suggest one positive use/application with the use of ChatGPT, My AI or a generative AI.

One good thing about using AI like ChatGPT is that it can help people do their work faster. For example, it can help writers write articles or code more quickly. This saves time and makes it easier for people to get their jobs done faster.

2 marks for reasonable strength (Fair description - limited understanding = 1 mark)

Question 9 - 5 marks

Operating systems are typically designed using layers. This can include mobile phones and tablets (like Android and IOS) and PCs or laptops (MacOS and Windows)

(a) Suggest one reason why operating systems are designed like this.

Operating systems are designed using layers because it makes things organized and easier to manage. Each layer has a specific job, like managing hardware or handling user interface, and they work together. This separation of tasks into layers makes it simpler to develop, maintain, and upgrade operating systems.
3 marks for reasonable reason (Fair description - limited understanding = 1 mark)

(b) Give one example of a hardware device in a computer and give its function.

One example of device hardware is the CPU (Central Processing Unit), often called the “brain” of a computer or device. The CPU follows instructions and does calculations for everything your device does, whether it’s running apps, browsing the web, or playing games. The CPU processes data and performs tasks, ensuring your device functions smoothly.
2 marks for reasonable example and role (Fair description - limited understanding = 1 mark)

Question 10 - 5 marks

"Below shows an image of some Python code. Study the code carefully and answer the questions that follow.

```
1 myList = [11, 13, 3, 9, 6, 1]
2
3 key = 7
4 found = False
5
6 #Part A start
7 for element in myList:
8     if element == key:
9         found = True
10 #Part A end
11
12 #Part B start
13 if found:
14     print("X")
15 else:
16     print("Y")
```

(a) Studying all of the code in part A carefully, explain specifically what the code in lines 7-9 does.

This code is a simple Python program that searches for a specific number (key) in a list called myList.
3 marks for reasonable explanation, must contain searching (Fair description - limited understanding = 1 mark)

(b) Currently, the print statements in line 14 and line 16 are not very informative. Give a meaningful message for the print statements in line 14 and line 16:

X: "The key", key,"was found in the list"
Y: "The key", key,"was not found in the list"
2 marks for reasonable outputs may include number etc and not key (1 each), (Fair description - limited understanding = 1 mark)

Question 11 - 5 marks

Websites are often not suitable for people with additional needs, such as vision impairment. On February the 2nd 2006, Facebook looked like the below:

- (a) Suggest a way to change this website to improve accessibility for people with vision impairments.

Any one of the below (or any other suitable):
Incorporate screen reader-friendly elements
Alt text
Text-to-Speech Integration

3 marks for reasonable addition (Fair description - limited understanding = 1 mark)

- (b) Identify one other addition or change you would make to the site for accessibility.

Any one of the below (or any other suitable):
Large font option
Different colour formats (for example beige backgrounds for some neurodiversity)
High contrast and scalable text

2 marks for reasonable addition (Fair description - limited understanding = 1 mark)

Question 12 - 5 marks

A school wants to develop an online interactive software system to take in and store students' exam results. The following stakeholders will interact with the system:

- Teachers can enter the results and review them.
- Parents and guardians can see the results.
- School management can see the results for winter and summer reports.

Assign two roles and responsibilities within a software development team to tackle this computing task.

Role 1: Software developer
Responsibility 1: To develop the software, to listen to the stakeholder requirements and to develop the system to meet these needs

Role 2: Database administer
Responsibility 2: to work with the software developer and the stakeholders to ensure that the database design meets both requirements, and is future proofed for the schools needs.

3 and 2 marks for each role and responsibility (1 and 1.5 respectively) (Fair description - limited understanding 1 mark)

Section B	Long Questions	78 marks
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Answer any two of three questions.

Question 13

39 (16, 10, 13)

(a) The below jumbled lines of code are meant to ask a user for their name, and print to the screen whether the name is valid or not. It will later be entered into a database so it is important to ensure the name is valid. To be valid, a name must:

- Have three or more characters
- Not have a space in it.

Write into the table on the right the order of the code blocks to create the program. Please note you can ignore indentation and there is one additional block that is not needed. The first row has been filled in for you.

1 <code>if len(name) > 2 and " " not in name:</code>		5
2 <code>print("Name Valid")</code>		1
3 <code>print("Name not valid")</code>		2
4 <code>else:</code>		4
5 <code>name = input("What is your name?")</code>		3
6 <code>if len(name) > 2 and " " in name:</code>		

4 marks for each correct

(b) For the one line of code that was not included for the solution for part a), what would have happened if it replaced the correct line of code that is similar to it?

If this was left in the name must include a space, rather than not including a space.
5 marks for identification of the space (Fair description - limited understanding = 2 marks)
5 marks for the effects of this (Fair description - limited understanding = 2 marks)

(c) For the overall algorithm to work as intended, a name must:

- Have three or more characters
- Not have a space in it.

This algorithm is not optimal as it may not work for all names. Can you think of a name or description of a name where the code might not work as intended and how you might fix it?

This may have issues if:
There is a double barrel first name such as Mary Jane
 To address this, spaces could be included, but perhaps a confirmation check is added before submitted, or to ask users to add hyphen (this may exclude other members). You could also check if a space was at the end as in a typo.
If the name was short such as AJ
 Perhaps use at least one character.
Note: these are not exhaustive:
5 marks for identification of two issues (Fair description - limited understanding = 2 marks)
8 marks each fix (Fair description - limited understanding = 2 marks)

Question 14

39 (16, 7, 8, 8)

Modelling is often used to build representations of real-world scenarios. In the below example, we have a model to tell us how far away lightning is by counting the time between seeing the lightning flash and hearing the thunder. The model is presented below.

- (a) Use the model to take the number of seconds between flash and thunder sound to determine how far the lightning is away in KM.

Seconds between flash and thunder	How far away in km
3	1
6	2
9	3
1	0.33

4 marks for each correct

- (b) The below Python program is missing one line of code for the model:

```
seconds = int(input("How many seconds between flash and thunder sound?"))
# Missing line of code
print("Distance:", distance, "KM")
```

What is the missing line of code, is it a), b) or c):

- a) `distance = seconds * 3`
 b) `distance = seconds / 3`
 c) `distance = seconds // 3`

Answer: B

7 marks for correct answer (c. 4 marks as an attempt)

- (c) Give two reasons why this model may be useful for people to use.

- For safety, this model could help people to determine how far the lightning is away from them, to help people to go outside etc.
- Education, this model serves as an educational tool, especially for children and those who are unfamiliar with the science behind thunder and lightning and the difference in the speed of sound and light.

8 marks 4 each (Fair description - limited understanding = 2 marks each)

- (d) **Models can sometimes be incorrect. Describe one problem that could occur if an incorrect answer was provided by the model.**

If the lightning distance model gives the wrong answer, it can be really dangerous. For example, if it says lightning is far when it's actually close, people might not take safety steps like going inside, thinking they have more time. This could lead to a higher risk of getting struck by lightning or facing other storm dangers. So, an incorrect answer from the model can make people not protect themselves properly during a storm, which is risky.

8 marks (Fair description - limited understanding = 2 marks each)

Question 15

39 (19, 20)

Below is a histogram of all the English-language Netflix films in the US in 2020 (they currently own the rights to over 4000 series and films).

Beside the histogram is the average, min and max length of films on Netflix.

- (a) **The longest English-language film on Netflix is *The Irishman*, running at 209 minutes (3 hours and 29 minutes). Can you spot any data ranges present in the histogram that may be incorrect? Why would you think this?**

What data is incorrect?

Any values above 209 minutes.

12 marks

How did you come to this conclusion?

As the Irishman is the longest film at 309 minutes, there should be no films that are longer, but there are, so these are incorrect.

7 marks

- (b) **Below is a dataset for US household income in 2016, presented as a histogram (number of households on the y axis and the amount of money the household brings in each year on the x axis).**

The figure reports two items, the mean and median, what do these two values tell you about the household income in the US in 2016? (you can also refer to other parts of the graph if you would like, but it is not essential).

As the mean is larger than the median, this means that the plot is right skewed. That means that there are some very high earners that are raising the mean, hiding inequalities. That means that the median or middle value shows that the majority are earning much less than the reported average. This inequality is not often shown when reporting the average wage in the US. This also shows that there is a divide in earning.

10 marks each discussing the differences in the values

(Fair description - limited understanding = 5 marks each)

10 marks for relating the meanings to the dataset, that is, the average does not tell the full story.

(Fair description - limited understanding = 5 marks each)

Section C

Programming

87 marks

Answer all question parts.

Question 16

(44 marks, 10, 10 and 24)

- (a) Computer programs can be used to make simple tools. One such tool is a converter for recipes, as many recipes change between spoons and cups and ml (millilitres). Open the program called Question16_A.py from your device. Enter your name in the space provided on line 2.

```
# Please enter name:

print("*****")
print("* Conversions *")
print("*****")
print("1) From teaspoons to ml")
print("2) From tablespoons to ml")
print("3) From cups to ml")
print("4) From ml to teaspoons")
print("5) From ml to tablespoons")
print("6) From ml to cups")

conversion = int(input("Please enter the conversion:"))

if conversion == 1:
    teaspoons = int(input("Please enter number of teaspoons:"))
    ml = teaspoons * 5
    print("The ml is:", ml)
elif conversion == 2:
    tablespoons = int(input("Please enter number of tablespoons:"))
    ml = tablespoons * 15
    print("The ml is:", ml)
```

The program asks the user what conversion they want to make, for example, if they select 1, then they will be converting from teaspoons to ml. When the program is run, the output may look as follows:

```
*****
* Conversions *
*****

1) From teaspoons to ml
2) From tablespoons to ml
3) From cups to ml
4) From ml to teaspoons
5) From ml to tablespoons
6) From ml to cups

Please enter conversion required from the menu, for example 1) to convert
teaspoons to ml:1
Please enter number of teaspoons:1
The ml is: 5.0
```

Modify the program to do the following:

- (i) At present, the program can only take in integers. Modify the program so the user will be able to enter floating-point numbers, like in the example output below:

```
*****
* Conversions *
*****
1) From teaspoons to ml
2) From tablespoons to ml
3) From cups to ml
4) From ml to teaspoons
5) From ml to tablespoons
6) From ml to cups
Please enter conversion required from the menu, for example 1) to convert
teaspoons to ml:1
Please enter number of teaspoons:2.5
The ml is: 12.5
```

```
if conversion == 1:
    teaspoons = float(input("Please enter number of teaspoons:"))
    ml = teaspoons * 5
    print("The ml is:", ml)
elif conversion == 2:
    tablespoons = float(input("Please enter number of tablespoons:"))
    ml = tablespoons * 15
    print("The ml is:", ml)
```

10 marks, 5 marks for each modification of input to float, could be done on separate line.

- (ii) The prompt is not very informative as the program is written currently. Modify the prompt to include an example so the user knows they need to enter a menu option from 1-6 before they can enter a number to be converted. Currently it reads:

```
conversion = int(input("Please enter the conversion:"))

conversion = int(input("Please enter conversion required from the menu, for
example 1) to convert teaspoons to ml:"))
```

10 marks, 5 marks adding it is from a menu and 5 marks to include the numbers.

- (iii) Currently, there are several conversions missing. Create the remaining conversions, that is, from the menu, conversion 3 to 6.

```
elif conversion == 3:
    cups = float(input("Please enter number of cups:"))
    ml = cups * 60
    print("The ml is:", ml)
elif conversion == 4:
    ml = float(input("Please enter number of ml:"))
    teaspoons = ml / 5
    print("The number of teaspoons is:", ml)
elif conversion == 5:
    ml = float(input("Please enter number of ml:"))
    tablespoons = ml / 15
    print("The number of tablespoons is:", tablespoons)
elif conversion == 6:
    ml = float(input("Please enter number of ml:"))
    cups = ml / 240
    print("The number of cups is:", cups)
```

24 marks, 6 marks for each conditional including algorithm

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

Question 16

(43 marks, 15, 15 and 13)

- (b) Computer programs can also be used to make Chatbots (like ChatGPT or My AI). In this program, the user will enter a prompt and the AI will reply. While some AI is very advanced, some AI is just a series of conditional statements, like in the code below: Open the program called Question16_B.py from your device. Enter your name in the space provided on line 2.

```
# Please enter name:

from datetime import datetime

prompt = input("Please enter prompt:")

if prompt.__contains__("hello"):
    print("Hi there, how are you?")
elif prompt.__contains__("name"):
    print("My name is ExamBot, how can I help?")
elif prompt.__contains__("time"):
    now = datetime.now()
    current_time = now.strftime("%H:%M:%S")
    print("Current Time =", current_time)
```

The program searches for key words in the sentence to try to understand what you are requesting; for example, if you say hello in the sentence the output will look like:

```
Please enter prompt: hello
Hi there, how are you?
```

Modify the program to do the following:

- (i) Even when dealing with Chatbots of My AI, sometimes the AI does not know the answer. Modify the program so that if we ask it something that it is not accounted for, the AI prints out that it does not know. The output may now look as follows:

```
Please enter prompt: how do chatbots work?
I am sorry, I do not know that one?
```

Hint: use an else condition.

```
else:
    print("I am sorry, I do not know that one?")
```

15 marks, 10 marks adding elif (or other appropriate) and 5 marks to include suitable output.

- (ii) Add a condition that if asked about the weather (where weather is contained in the sentence), it prints out that it is always sunny in Ireland. When the program is run the output may now look as follows:

```
Please enter prompt: what is the weather like?
It is always sunny in Ireland
```

```
elif prompt.__contains__("weather"):
    print("It is always sunny in Ireland")
```

15 marks, 10 marks adding elif (or other appropriate) and 5 marks to include suitable output.

- (iii) Currently all prompts must contain the key word as lower case, amend the program so that it does not matter if the key words are in upper or lower case. For example:

```
Please enter prompt: what is the Weather like?  
It is always sunny in Ireland
```

Or

```
Please enter prompt: what is the weather like?  
It is always sunny in Ireland
```

```
prompt = input("Please enter prompt:")  
  
prompt = prompt.lower()
```

13 marks selecting/changing to a single case (or other appropriate) must be suitable for the conditionals (-6 if not).

Full programme for reference:

```
# Please enter name:  
  
from datetime import datetime  
  
prompt = input("Please enter prompt:")  
  
prompt = prompt.lower()  
  
if prompt.__contains__("hello"):  
    print("Hi there, how are you?")  
elif prompt.__contains__("name"):  
    print("My name is ExamBot, how can I help?")  
elif prompt.__contains__("weather"):  
    print("It is always sunny in Ireland")  
elif prompt.__contains__("time"):  
    now = datetime.now()  
    current_time = now.strftime("%H:%M:%S")  
    print("Current Time =", current_time)  
else:  
    print("I am sorry, I do not know that one?")
```



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