



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2024

Marking Scheme

Computer Science

Higher Level

Note to teachers and students on the use of published marking schemes

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. This training involves, among other things, marking samples of student work and discussing the marks awarded, so as to clarify the correct application of the scheme. The work of examiners is subsequently monitored by Advising Examiners to ensure consistent and accurate application of the marking scheme. This process is overseen by the Chief Examiner, usually assisted by a Chief Advising Examiner. The Chief Examiner is the final authority regarding whether or not the marking scheme has been correctly applied to any piece of candidate work.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates' work and the feedback from all examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination and the need to maintain consistency in standards from year to year. This published document contains the finalised scheme, as it was applied to all candidates' work.

In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when in doubt.

Future Marking Schemes

Assumptions about future marking schemes on the basis of past schemes should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination in a given year. The Chief Examiner in any given year has the responsibility to determine how best to ensure the fair and accurate assessment of candidates' work and to ensure consistency in the standard of the assessment from year to year. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination are subject to change from one year to the next without notice.

Marking Scheme – Section C

Structure of the marking scheme for Section C (Programming)

Candidate responses are marked according to different scales, depending on the types of response anticipated. For example, scales labelled B divide candidate responses into three categories (correct response, response with some merit, and response of no substantial merit), and so on. The scales and the marks that they generate are summarised in this table:

Scale Label	A	B	C	D
No. of categories	2	3	4	5
5 mark scale	0, 5	0, 3, 5	0, 2, 3, 5	
10 mark scale				0, 3, 5, 7, 10
15 mark scale				0, 5, 8, 12, 15

A general descriptor of each point on each scale is given below. More specific directions in relation to interpreting the scales in the context of each question are given in the scheme, where necessary.

Marking scales – level descriptors

A-scales (2 categories)

- response of no substantial merit
- correct response

B-scales (3 categories)

- response of no substantial merit
- response with some merit
- correct response

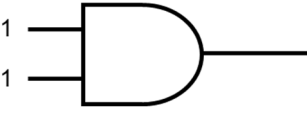
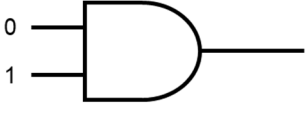
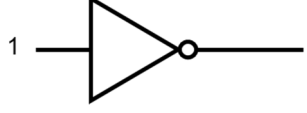
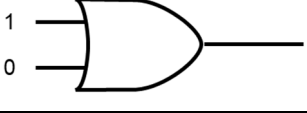

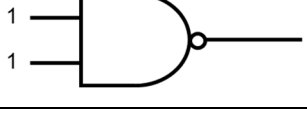
C-scales (4 categories)

- response of no substantial merit
- response with some merit
- almost correct response
- correct response

D-scales (5 categories)

- response of no substantial merit
- response with some merit
- response about half-right
- almost correct response
- correct response

Section A**Short Answer Questions****54 marks**Answer any **nine** questions.**Question 1****6 marks**

Column A Logic gate with input(s)	Column B Output
	1
	0
	0
	1
	0
	0

Each correct response 1 mark

Question 2**6 marks****Answer: 27 30 33 36**

Each correct value in order (x 4) 1 mark
 Space between each value 2 marks

Question 3**6 marks****Answer: 0111 1001**

Correct including leading zero 6 marks

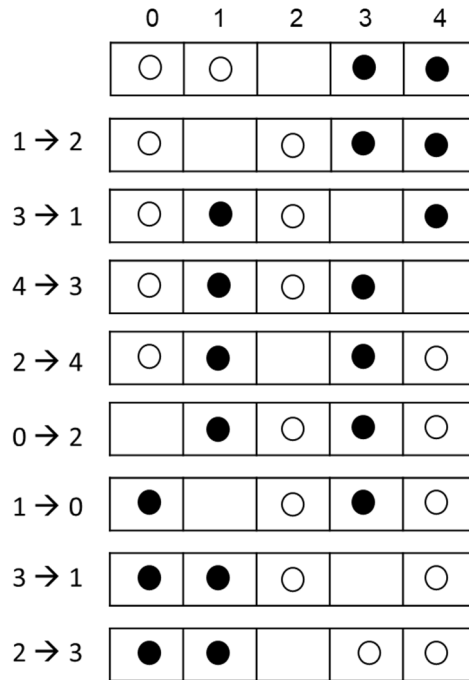
Correct without leading zero 5 marks

For each calculation error deduct 2 marks

Response with some merit 2 marks

Question 4

6 marks



Full correct solution

6 marks

Four or more correct steps in the correct order

4 marks

Response with some merit

2 marks

Question 5

6 marks

Turing Machines

- First abstract model for computability
- If something was computable it could be computer by a Turing Machine
- They were used to prove that not everything was computable i.e. limits of computation

Transistors

- Replaced bulky and less reliable vacuum tubes, enabling the development of smaller, faster, and more energy-efficient electronic devices. This laid the foundation for modern semiconductor technology.

Integrated Circuits

- Integrated circuits are orders of magnitude smaller, faster, and less expensive than those constructed of discrete components, allowing a large transistor count.

ARPANET

- Considered the forerunner or the internet – many of the protocols used by modern computer networks were developed for ARPANET

Microprocessors

- The microprocessor enabled the integration of computing power on a small chip. This development led to the rapid advancement of personal computers and other electronic devices.

Personal Computers

- **Personal computers have revolutionised the way individuals work, learn, and connect with others. Their affordability made them much more accessible for people to use in their daily lives to access information, communication and productivity tools easily accessible to everyone.**

Very good explanation - clear understanding demonstrated 6 marks

Good explanation - clear information, lacking demonstration of full understanding 4 marks

Fair explanation - limited understanding 2 mark

Question 6

6(3,3) marks

Examples of Unit Test Cases

- **Update user's profile picture.**
- **Posting content**
 - messaging - sending /receiving messages,
 - image sharing
- **Connecting with friends**
- **Displaying online status,**
- **Privacy settings, work correctly (on their own)**
- **Evaluate all execution paths (or as many as possible)**
- **Any other valid unit test case**

Examples of System Test Cases

- **End-to-end testing of entire application**
- **Handles a realistic number of simultaneous users**
- **Handles multiple chat sessions simultaneously**
- **Ensures that system provides a user-friendly experience**
- **Complies with privacy and security regulations.**
- **Any other valid system test case**

For unit test and system test example:

Very good example - clear understanding demonstrated 3 marks

Fair example – limited understanding 2 mark

Question 7

Potential Advantages of Quantum Computing

- **Speed - quantum computers have the potential to solve certain problems much faster than classical computers. This can lead to breakthroughs in fields such as cryptography, medicine, climate modelling etc.**

Potential Disadvantages of Quantum Computing

- **Cost – quantum computers are expensive to develop and build and are very expensive to run and maintain.**

- The immense power of quantum computers could break current cryptographic algorithms, posing a significant risk to data security and privacy. Existing encryption methods may become obsolete, necessitating the development of new quantum-resistant cryptography

Potential Advantages of Edge Computing

- **Faster response times** - By processing data closer to where it is generated (at the edge of the network), edge computing reduces latency, which is critical for real-time applications such as autonomous vehicles, industrial automation, and remote healthcare.
- **Improved Privacy and Security:** Edge computing allows sensitive data to be processed locally, reducing the need to transmit large amounts of raw data. This can enhance privacy and security, as critical data stays closer to its source and is subject to fewer points of potential vulnerability.

Potential Disadvantages of Edge Computing

- **Limited Processing Power and Storage** - edge devices typically have less processing power and storage capacity compared to large, centralised servers. This limitation can constrain the types of computations that can be performed at the edge and may require careful resource management.
- **Management Complexity and Scalability Challenges** - edge computing introduces a more distributed architecture, leading to increased complexity in managing and maintaining a network of edge devices.

Potential Advantages of the Internet of Things (IoT)

- **Improved Convenience and Efficiency:** IoT enables smart homes, smart cities, and smart industries by connecting various devices and systems. This connectivity can lead to improved convenience in daily life. The fact that data is gathered and processed in real-time leads to improved efficiency in industrial processes.

Potential Disadvantages of the Internet of Things (IoT)

- **Privacy Issues:** IoT devices often collect sensitive personal data, and if not handled properly, there is a risk of unauthorised access or misuse. Striking a balance between the benefits of data collection and user privacy is a critical challenge.
- **Security Concerns:** IoT devices are often vulnerable to security breaches. The interconnected nature of these devices creates potential entry points for cyberattacks.

Potential Advantages of Biometric Authentication

- **Enhanced Security** - biometric authentication provides a high level of security by relying on unique biological characteristics such as fingerprints, facial features, or iris patterns. It is difficult for unauthorised individuals to replicate or forge these characteristics, making it a robust method of user authentication.
- **Convenience and User-Friendly** - biometric authentication is often more convenient for users compared to traditional methods like passwords or PINs. Users do not need to remember complex passwords, and the authentication process is typically quick and seamless, contributing to a positive user experience.

Potential Disadvantages of Biometric Authentication

- **Privacy Concerns** - users may be hesitant to share such sensitive information as their own biometric data, fearing that it could be misused or compromised.
- **Biometric Spoofing and False Positives** - biometric systems are not immune to spoofing attacks where unauthorised users attempt to replicate biometric features to gain access.

Additionally, false positives (incorrectly authenticating an unauthorised user) and false negatives (rejecting an authorised user) can occur, impacting the reliability of the system.

Potential advantages of Blockchain Technology:

- **Transparency and Security:** Blockchain technology offers a decentralised and transparent way to record transactions, which can enhance security and trust in various systems, such as financial transactions, supply chain management, and voting systems as there is no single point of control or failure. Security is enhanced because once information is recorded on the blockchain, it is extremely difficult to alter due to the cryptographic principles used in the technology.

Potential disadvantages of Blockchain Technology:

- **Privacy Concerns** - while the transparency of blockchain is an advantage, it can also be a disadvantage. Because all transactions are recorded on a public ledger, it can be possible to trace transactions back to individuals.
- **Energy Consumption** - many blockchain networks require substantial computational power and energy consumption for mining and validating transactions. This has raised environmental and sustainability concerns.

For each potential advantage

- Very good description - clear understanding of emerging trend demonstrated 3 marks
- Fair description – limited understanding of emerging trend 2 mark

For each potential disadvantage

- Very good description - clear understanding of emerging trend demonstrated 3 marks
- Fair description – limited understanding of emerging trend 2 mark

Question 8

6(3,3) marks

Data in RAM

- **System Software e.g. operating system**
- **Application Software e.g. office productivity software**
- **Programs e.g. python programs and data e.g. documents**
- **Any temporary data**

Data in ROM

- **Firmware – the software embedded into hardware devices**
- **Basic Input Output System (BIOS) - essential for the computer's startup.**
- **Bootstrap programs**
- **System level configuration data**
- **Any permanent data necessary for the device to operate**

For each of RAM and ROM:

- Very good example - clear understanding demonstrated 3 marks
- Fair example – limited understanding 2 mark

Question 9

6(3,3) marks

The two rules are:

- If the year is evenly divisible by 400 it is a leap year e.g. 2000 was a leap year
- If the year is evenly divisible by 4 and not 100 it is a leap year e.g. 2024 is but 2025 and 2100 are not

For each rule:

Very good description - clear understanding demonstrated	3 marks
Fair description – limited understanding	2 marks

Question 10

Any two from the following:

- **Equitable Use** - by incorporating accessibility features such as adjustable font sizes, colour contrasts, and audio feedback the design can ensure that the interface is usable by people with varying abilities.
- **Flexibility in Use** - this principle could be met by providing features that allows the users to interact with the system in different ways e.g. via touch screen or voice commands.
- **Simple and Intuitive Use** - this can be achieved in the design by a straightforward and intuitive menu structure with easily understandable icons and labels. Avoid unnecessary complexity to make the interface user-friendly for individuals with different levels of experience.
- **Perceptible Information** - the system should communicate necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities. For example, the menu and instructions on how to pay could be provided through multiple modalities, such as visual cues, text labels, and audio instructions, to cater to users with different sensory capabilities.
- **Tolerance for Error** - this can be achieved by including features like confirmation dialogs, clear feedback messages, and the ability to review orders before finalising.
- **Low Physical Effort** - the system should ensure that the touch interface is responsive to different levels of pressure, accommodating users with varying physical abilities. Consider alternative input methods for users who may have difficulty with touchscreens.
- **Size and Space for Approach and Use** - the kiosks should be designed with varying heights to accommodate users of different statures or those using mobility aids. Ensure there's enough space for wheelchair users to approach and interact comfortably.

For each correctly named principle of universal design 1 mark

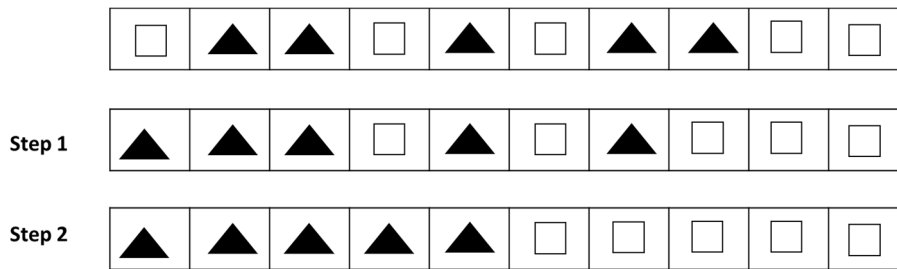
For each explanation:

Very good explanation - clear understanding demonstrated	2 marks
Fair explanation – limited understanding	1 mark

Question 11

6(4,2) marks

(a)



- In Step 1 the algorithm has swapped the square from position 0 with the triangle in position 7.
- In Step 2 the algorithm has swapped the square from position 4 with the triangle in position 6.
- This leaves a final state with all the triangles to the left of all the squares.

For each correct step 2 marks

Response with some merit 2 marks

(b)

- A general solution provides a broad approach that can be applied to different situations
- A general solution will always produce the correct output regardless of the input
- The algorithm does not depend on the size of the input e.g. the number of squares and triangles.

Very good explanation - clear understanding demonstrated 2 marks

Fair explanation – limited understanding 1 mark

Question 12

6(3,3) marks

(a)

- The meaning of the quote is that when a service such as social media is free, the users become a commodity for these platforms, and their attention and data are the actual products that are monetised. As users interact with social media platforms, they generate valuable data (through their preferences, behaviours etc.). This data is then collected, analysed, and used to create targeted advertising or sold to third parties for various purposes, such as market research or influencing user behaviour.
- The quote serves as a reminder that even though users may not be directly paying for the service with money, they are indirectly paying with their personal information and attention.

Very good explanation - clear understanding demonstrated 3 marks

Fair explanation – limited understanding 2 mark

(b)

- **Privacy** - users often share personal information that becomes valuable for targeted advertising.
- **Manipulation of attention** – excessive use of online platforms can lead to addictive usage patterns, foster a comparison culture which in turn can have a negative impact on mental health.
- **Responsible use** - on a positive note, the quote can serve as an educational tool, promoting digital literacy and empowering users to make informed decisions about their online activities such as reading terms and conditions.

Very good explanation - clear understanding demonstrated 3 marks

Fair explanation – limited understanding 2 mark

Section B**Long Questions****76 marks**Answer any **two** questions.**Question 13****38 (11, 15, 12) marks****(a)****11 (3,3,3, 2) marks****(i)****3 marks**

Any response that captures the essence of any of the following:

- **Artificial intelligence can be defined as the science and engineering of making intelligent computer programs capable of performing tasks that require subtleties of judgement, interpretation and generalisation that we associate with human intelligence.**
- **The design and study of systems that appear to mimic intelligent behaviour**
- **The theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision making and translation between languages.**

Very good explanation - clear understanding demonstrated 3 marks

Fair explanation – limited understanding 2 mark

(ii)**3 marks**

- **Narrow AI: Refers to AI systems built to perform a single task but without any skills that can be transferred to other tasks.**
- **Artificial General Intelligence (AGI) refers to AI systems that can autonomously solve a variety of complex problems in a variety of different domains and learn and adapt autonomously.**

Very good distinction - clear understanding demonstrated 3 marks

Fair distinction – limited understanding 2 mark

(iii)**3 marks**

- **Generative AI is an Artificial Intelligence (AI) technology that automatically generates new/original content in response to prompts typed in by the user.**
- **Generative AI should be used with caution as it is not always correct – a phenomena known as hallucination.**

Very good explanation - clear understanding demonstrated 3 marks

Fair explanation – limited understanding 2 mark

(iv)

2 marks

Any two from the following:

- text (written in any natural language)
- images (e.g. photographs, digital paintings and cartoons)
- videos
- music
- software code
- any reasonable format that could be produced by GenAI

For each correctly identified format

1 mark

(b)

15 (2, 6, 4, 3) marks

(i)

2 marks

- The percentages represent a level of confidence returned by the model that the image has been correctly classified as the associated label. For example, *cat: 94%* means that the algorithm is 94% confident that it has identified a cat on this part of the image.

Very good explanation - clear understanding demonstrated

2 marks

Fair explanation - limited understanding demonstrated

1 mark

(ii)

6 (3, 3) marks

Any two from the following:

- Computer vision can be used for early detection of diseases through medical imaging.
- Computer vision technology can be used in self-driving cars (autonomous vehicles) to improve road safety by enabling vehicles to detect and respond dangers such as pedestrians, cyclists, other vehicles, animals etc, in real-time, reducing the risk of accidents.
- Computer vision can be applied to eliminate the need for checkouts in supermarkets and other retail outlets thereby improving the shopping experience for customers and reducing the incidence of theft.
- Computer vision can analyse aerial imagery to monitor crop health, detect diseases, and optimise irrigation. This helps farmers make informed decisions, increase crop yield, and reduce the use of pesticides and water.
- Facial Recognition technology has the potential to enhances security by identifying and tracking individuals in public spaces, airports, and other high-security areas.
- Computer vision can be used in robots to visually recognise and assemble complex products, enhancing efficiency and precision in manufacturing.
- Computer vision can be used to monitor and track endangered species, helping conservationists protect wildlife and their habitats.

- **Augmented reality applications using computer vision can enhance interactive learning experiences, making education more engaging and accessible.**
- **Any reasonable application of computer vision and associated benefit.**

For each correctly named application of computer vision technology 1 mark

For each benefit:

Very good explanation - clear understanding demonstrated 2 marks
 Fair explanation – limited understanding 1 mark



(iii) 4 (2, 2) marks

- **Scenario 1. An online streaming service that recommends films based on users' viewing habits.**
 - **AI: The system could use machine learning algorithms to analyse user behaviour and make personalised suggestions, which would qualify it as AI. The service will use the viewing habits of the user, compare it to other users, and make a prediction of what the user would like to watch next. There are too many users of an online streaming service to be able to create rules for each user.**
 - **Not AI: Possible reasons include privacy concerns, limited data, resource constraints or preference for simplicity.**
- **Scenario 2. An automated lawnmower that uses sensors to navigate an outdoor space and avoid obstacles while cutting the grass.**
 - **AI (robotics): The automated lawnmower uses sensors to navigate, which involves some level of AI for obstacle avoidance and path planning.**
 - **Not AI: While it does employ sensors and automation, it typically relies on predefined rules (rather than machine learning techniques) to move around and avoid collisions. Automated lawnmowers typically don't learn or adapt to their environment. Therefore, they are often categorised as robotics or automation rather than AI.**

For each justification (no marks for stating yes/no):

Very good explanation - clear understanding demonstrated 2 marks
 Fair explanation – limited understanding 1 mark



(iv) 3 marks

Any one of the following:

- **Diversity of images used in training datasets – ensure that the training dataset is diverse enough to represent the target population**
- **Equality of representation of target population in training dataset- – ensure that the images used are representative of the target population**
- **Size of training datasets – it is likely that larger datasets will result in more accurate models with less bias than models trained using smaller datasets.**

- **Human in the loop** e.g. ensure proper diversity of race, gender etc. in development team
- **Monitoring and Bias Auditing** – continually monitor the training dataset to reflect changes in society and conduct bias audits to identify and address any biases that might have inadvertently crept in.
- **Any other reasonable method to reduce bias.**

Very good explanation - clear understanding demonstrated 3 marks
 Fair explanation – limited understanding 2 mark

(c)

12 marks

Points for supporting the initiative:

- **Ethical concerns:** time is needed to make sure that AI aligns with human values and doesn't compromise principles such as privacy, accountability, and fairness.
- **Jobs/Employment/Economy:** the pace of current development of AI systems has the potential to put many jobs at risk and people out of work. Pausing development provides an opportunity to address the potential societal impact on employment and consider strategies such as reskilling and implementing policies to mitigate economic disparities.
- **Security Risks:** Advanced AI systems, if developed without sufficient safeguards, pose potential security risks. Pausing development allows time to assess and address security concerns related to the misuse of AI, such as cyber threats, hacking, and the development of AI-driven weaponry.
- **Unintended Consequences:** The complexity of advanced AI systems increases the risk of unintended consequences. Pausing development permits a more thorough evaluation of the potential risks and unintended outcomes, ensuring that AI is deployed responsibly and doesn't lead to unforeseen negative impacts on society.
- **Existential Threat:** There are some who believe that the development of highly advanced AI systems (superintelligent AI) could potentially threaten the continued existence of humanity. A pause in AI would give more time to increase public awareness through open discussions about the risks and benefits of advanced AI.
- **Elaboration of any other reasonable point for pausing development of advanced AI systems**

Points against the initiative:

- **Innovation and Progress:** Continued development of advanced AI fosters innovation, leading to breakthroughs in various fields, including healthcare, education, and scientific research. Pausing development could impede progress and delay the benefits that AI can bring to society.
- **Societal Advancements:** AI has the potential to address complex societal challenges, such as climate change, healthcare disparities, and resource management. Halting development may hinder the application of AI in finding solutions to pressing global issues.
- **Competitive Disadvantage:** Countries and organisations are in a race to develop and adopt AI technologies. Pausing development may result in a competitive disadvantage, with nations that continue AI advancements gaining a lead in economic, military, and technological spheres.
- **Job Creation and Economic Growth:** While AI may lead to job displacement in certain sectors, it also has the potential to create new jobs and stimulate economic growth. Pausing

development could limit the positive economic impact of AI, affecting industries that could benefit from increased efficiency and innovation.

- **Elaboration of any other reasonable point against pausing development of advanced AI systems**

For each separate point made for and against the initiative up to a maximum of two points each:

Very good explanation - clear understanding demonstrated	3 marks
Fair explanation – limited understanding	2 mark

Question 14

38 (9, 14, 15) marks

(a)

9 (2, 3, 4) marks

(i)

2 marks

- Input variable 1: a
- Input variable 2: b

Each correct response 1 mark

(ii)

3 marks

- t is a temporary variable used to store the value of a
- Without t, the contents of a would be lost when b is assigned to a

Very good explanation - clear understanding demonstrated 3 marks

Fair explanation – limited understanding 2 mark

(iii)

4 (2, 2) marks

Advantages

- They are easier to understand than code (especially for non-programmers).
- The visual representation of flowcharts clearly depicts the flow and logic of an algorithm.
- They are independent of any programming language.
- They are flexible tools used to represent algorithms during the design stage of the design process.

Disadvantages

- They take a significant amount of time to develop.
- They can become unwieldy for detailed and complex algorithms.
- Lack of standards can lead to ambiguity and cause confusion.

For each advantage/disadvantage

Very good explanation - clear understanding demonstrated 2 marks

Fair explanation – limited understanding 1 mark

(b)

14 (1, 1, 1, 2, 3, 6) marks

(i)

1 mark

- the data type of the variable, values. Is a list (array)

Correct response 1 mark

- (ii) 1 mark
- the index of the element 70 is 1

Correct response 1 mark

- (iii) 1 mark
- the Python expression, `len(values)` returns 5

Correct response 1 mark

- (iv) 2 marks
- the slice expression, `values[2:4]` returns the list, `[30, 60]`

Full correct response 2 marks
Response with some merit 1 mark

- (v) 3 marks
- the expression `values[5]` would generate a runtime error because the index 5 is out of bounds

Very good explanation - clear understanding demonstrated 3 marks
Fair explanation – limited understanding 2 mark

- (vi) 6 (3, 3) marks

Advantages

- Binary search requires a dataset to be sorted
- Sorted data can be more user friendly e.g. social media timeline sorted by date/time, product catalogue sorted by cost etc.
- Sorted data can also make it easier for data analysis e.g. finding the median or quartiles of a set of data or identifying patterns/trends and outliers

Disadvantages

- sorting algorithms can take time
- sorting algorithms can consume valuable computational resources such as CPU and memory.
- If a dataset is already sorted (or almost sorted) the time and resources spent on sorting may not provide significant benefits.

- the efficiency of sorting algorithms can vary dramatically depending on the size of the input dataset, and the size of the dataset may not always be known in advance. This places a burden on designers/programmers to have a detailed understanding of the sorting algorithm being used and an awareness of the implications under all circumstances.
- Once a dataset is sorted there is a cost to maintaining the dataset in a sorted state

For each advantage/disadvantage
Valid statement 3 marks

(c) 15 (5, 5, 5) marks

(i)

Initial state of values:	50	70	30	60	20
After pass 1:	50	30	60	20	70
After pass 2:	30	50	20	60	70
After pass 3:	30	20	50	60	70
After pass 4:	20	30	50	60	70
After pass 5:	20	30	50	60	70

For each pass correctly completed 1 mark

(ii) 5 marks

- In a list of size N the bubble sort algorithm performs N passes. On each pass it will perform $N-1$ compare operations. This gives a total of $N^2 - N$ operations. For large N this is approximately the same as N^2 . Hence we write $O(N^2)$.
- The best-case scenario is when the input list is already sorted. The worst-case scenario is when the input list is in reverse order. In both scenarios bubble sort will also carry out the same number of comparisons.
- As the number of elements increases the number of compare operations increases quadratically (by a power of 2). For example, the number of compare operations carried out by a bubble sort algorithm on a list of size 5 would be of the order of 25. If you double the size of the input list, the number of compare operations could increase by a factor of four.

Very good explanation - clear understanding demonstrated 5 marks

Good explanation - clear information, lacking demonstration of full understanding 3 marks
Fair explanation - limited understanding 1 mark

(iii)

5 marks

Enhancement 1 (reducing size of list by 1 on each pass)

- On the 1st pass the largest item in the list is moved to the rightmost position
- The 2nd pass moves the next largest item to the second last position
- Each pass moves the largest item remaining to its correct position towards the end of the list
- The standard algorithm continues to compare adjacent elements that are already sorted at the end (right) of the list even though they are already sorted.
- The algorithm can be enhanced by preventing these unnecessary comparisons.
- This can be achieved by reducing the number of adjacent compares by 1 on each pass as shown in the implementation below.

```
L = [50, 20, 70, 40, 60]
for i in range(len(L)):
    for j in range(len(L)-1-i):
        if L[j] > L[j+1]:
            temp = L[j+1]
            L[j+1] = L[j]
            L[j] = temp
```

OR

Enhancement 2 (halting if no swaps made during any pass)

An alternative enhancement can be achieved by introducing a 'flag' to indicate whether a swap was needed on a particular pass. If no swap was performed the list is deemed to be sorted and the algorithm can end regardless of the number of passes complete e.g. if the initial list is sorted there won't be any swaps on the 1st pass. Therefore, the algorithm can be terminated.

```
L = [50, 20, 70, 40, 60]
for i in range(len(L)):
    swap = False
    for j in range(len(L)-1):
        if L[j] > L[j+1]:
            temp = L[j+1]
            L[j+1] = L[j]
            L[j] = temp
            swap = True
    if swap == False:
        break
```

Very good explanation - clear understanding demonstrated 5 marks
Good explanation - clear information, lacking demonstration of full understanding 3 marks
Fair explanation - limited understanding 1 mark

Question 15

38 (12, 16, 10) marks

(a)

12 (4, 3, 2, 3) marks

(i)

4 marks

Database

- **A database is a collection of structured data organised in a way such that the data can be easily and efficiently retrieved and maintained (added to, changed/updated and deleted).**
- **The data is organised into entities also known as tables which are structured sets of rows and columns. Each table typically correspond to a specific entity (person, place or thing) such as customer, country, order, product or book**

Record

- **Is a single row of data (also known as a tuple)**
- **Each record contains a set of related elements or fields**

For each term:

Very good explanation - clear understanding demonstrated 2 marks

Fair explanation – limited understanding 1 mark

(ii)

3 (1, 2) marks

Primary Key: book_id

Justify: The value of book_id is guaranteed to be unique for each separate record

Primary Key correctly identified 1 mark

Justification:

Very good justification – clear understanding demonstrated 2 marks

(iii)

2 (1, 1) marks

Any two from the following:

- **The use of the euro symbol in the cost field in record number 3 is inconsistent with the way cost is specified in the other records i.e. €10 versus 6.95, 8.95 and 9.95**
- **The name of the author in record number 3 is inconsistent with the names in the other records i.e. Doc Seus is inconsistent with Dr. Seuss**
- **the format used in the author_dob field is dd/mm/yyyy in records 1 and 3. A different format is used in records 2 (mmm d, yyyy) and 4 (American, mm/dd/yyyy).**
- **The values used in the on_loan field are inconsistent. Yes and Y are used to indicate that a books 1 and 2 are out on loan whereas N and No are used to indicate books with id values of 3 and 4 are not on loan.**

Each correctly identified inconsistency 1 marks

(iv)

3 marks

Column A Data Type	Column B Field Name
Boolean	on_loan
String	title, author, author_dob
Real	cost

Note: The above table shows the only acceptable answers

Each correct response 1 mark

(b)

16 (6, 4, 3, 3) marks

(i)

6 marks

member_id	member_name
1	Amy
2	Bill
3	Chloe

MEMBERS

member_id	book_id	date_borrowed
3	2	20/05/2024
1	4	01/05/24
2	1	18/05/2024
3	3	15/05/2024

LOANS

Each correct response 1 mark

(ii)

4 (1, 3) marks

Possible answers are:

- Foreign Key: member_id
- Explanation: This links the LOANS table with the MEMBERS table

OR

- Foreign Key: book_id
- Explanation: This links the LOANS table with the BOOKS table

Foreign Key correctly identified 1 mark

Very good explanation - clear understanding demonstrated 3 marks

Fair explanation – limited understanding 2 mark

(iii) 3 marks

- **The presence of a record in the LOANS table can be used to infer that a book is on loan. (Not only that, but the date the book was borrowed can also be looked up.) Therefore, there is no need to store this information in BOOKS.**

Very good explanation - clear understanding demonstrated 3 marks

Fair explanation – limited understanding 2 mark

(iv) 3 marks

- **Data redundancy refers to a situation where a single piece of data (or value) is stored in more than one place in a database. It usually occurs as a result of poor design and is considered bad practice as it can lead to data inconsistencies as well as inefficiency use of storage.**

Very good explanation - clear understanding demonstrated 3 marks

Fair explanation – limited understanding 2 mark

(c) 10 (4, 6) marks

(i) 4 marks

Any two statements from the following:

- **The most/least popular book is X.**
- **The most popular time/season to borrow books is Y**
- **A particular user demographics (e.g. age, gender, location) prefer certain types of books.**
- **Certain books (e.g. expensive books) are more likely to be returned on time than others.**
- **Member A is more likely to return their books in time than member B**
- **PR campaign results in an increase in borrowing of X%**
- **Any reasonable hypothesis presented as a statement.**

For each hypothesis:

Very good explanation - clear understanding demonstrated 2 marks

Fair explanation – limited understanding 1 mark

(ii) 6 (3, 3) marks

Any two from the following:

- **Missing Values: Data entries that are incomplete or entirely absent can be filled in with appropriate values or removed if they are not critical.**
- **Duplicate Records: Repeated entries that skew analysis and statistics can be identified and eliminated to ensure each data point is unique.**

- **Inconsistent Formatting:** Variations in data formatting (e.g. date formats, capitalisation, unit measurements) can be standardised for consistency.
- **Outliers and Anomalies:** Data points that deviate significantly from the norm can be investigated and corrected or removed if they are erroneous.
- **Incorrect Data Types:** Values that are in the wrong format or type (e.g. text in a numerical field) can be converted to the correct type or corrected as needed.
- **Typographical Errors:** Spelling mistakes, typographical errors, and other text inaccuracies can be corrected to ensure data consistency and accuracy.
- **Inconsistent Categories:** Categorical data that uses different labels for the same category (e.g. "Y" vs. "Yes") can be standardised to unify the categories.
- **Any other relevant error e.g. Invalid entries - data that do not conform to the expected rules or ranges (e.g., negative ages, future dates for past events) can be identified and corrected or removed.**

For each type of error correctly identified 1 mark

For each description:

Very good description - clear understanding demonstrated 2 marks

Fair description – limited understanding 1 mark

Question 16

80 (50, 30) marks

(a)

50 (5, 5, 5, 5, 5, 10, 15) marks

Possible solution:

```
1 # Question 16 (a)
2 # Examination Number:
3 from random import choice
4
5 fruits = ['apple', 'cherry', 'orange']
6
7 random_fruit_1 = choice(fruits)
8
9 # (i) Write a line of code to display (print) the value of random_fruit_1 in a
10 # message as shown:
11 print("Random Fruit 1:",random_fruit_1) # (i)
12
13 # (ii) Add statements to initialise and display two variables to random fruits from
14 # the list
15 # You should name the variables random_fruit_2 and random_fruit_3
16 random_fruit_2 = choice(fruits) # (ii)
17 print("Random Fruit 2:",random_fruit_2) # (ii)
18 random_fruit_3 = choice(fruits) # (ii)
19 print("Random Fruit 3:",random_fruit_3) # (ii)
20 print()
21
22 # (iii) Add a line of code to display FIRST FRUIT IS CHERRY if the first fruit is a
23 # cherry
24 if (random_fruit_1 == 'cherry'):
25     print("FIRST FRUIT IS CHERRY")
26
27 # (iv) Add a line of code to display FIRST PAIR MATCH if the first two fruits are
28 # the same/match
29 if (random_fruit_1 == random_fruit_2):
30     print("FIRST PAIR MATCH")
31
32 # (v) Add a line of code to display FIRST PAIR ARE CHERRIES if the first two fruits
33 # are the same/match
34 if (random_fruit_1 == random_fruit_2) and (random_fruit_1 == 'cherry'):
35     print("FIRST PAIR ARE CHERRIES ")
36
37 # (vi) Add a line of code to display MATCHING PAIR if any two fruits are the
38 # same/match
39 if (random_fruit_1 == random_fruit_2) or (random_fruit_1 == random_fruit_3) or
40 (random_fruit_2 == random_fruit_3):
41     print("MATCHING PAIR")
42
43 # (vii)
44 # Write a loop that iterates 100 times.
45 # On each iteration the loop body should generate a random fruit.
46 # After the loop is executed the program should display a count of the number of
47 # times each fruit was generated.
48 random_fruits = []
49 for i in range(100):
50     random_fruit = choice(fruits)
51     random_fruits.append(random_fruit)
52
53 for i in range(len(fruits)):
54     print(fruits[i], random_fruits.count(fruits[i]))
```

(i)

5 marks (C-5 scale)

5 marks	Correct response Correct implementation using solution above or similar.
3 marks	Almost correct response Correct implementation using solution above or similar but with minor syntax or semantic error.
2 marks	Response with some merit Any other reasonable attempt.

(ii)

5 marks (C-5 scale)

5 marks	Correct response Correct implementation using solution above or similar.
3 marks	Almost correct response Correct implementation using solution above or similar but with minor syntax or semantic error.
2 marks	Response with some merit Any other reasonable attempt.

(iii)

5 marks (C-5 scale)

5 marks	Correct response Correct implementation using solution above or similar.
3 marks	Almost correct response Correct implementation using solution above or similar but with minor syntax or semantic error.
2 marks	Response with some merit Any other reasonable attempt.

(iv)

5 marks (B-5 scale)

5 marks	Correct response Correct implementation using solution above or similar.
3 marks	Response with some merit Any other reasonable attempt.

(v)

5 marks (B-5 scale)

5 marks	Correct response Correct implementation using solution above or similar.
3 marks	Response with some merit Any other reasonable attempt.

(vi)

10 marks (D-10 scale)

10 marks	Correct response Correct implementation using solution above or similar.
7 marks	Almost correct response Correct implementation using solution above or similar but with minor syntax or semantic error.
5 marks	Response about half-right Partially correct implementation using solution above or similar but with significant syntax or semantic error.
3 marks	Response with some merit Any other reasonable attempt.

(vii)

15 marks (D-15 scale)

15 marks	Correct response Correct implementation using solution above or similar.
12 marks	Almost correct response Correct implementation using solution above or similar but with minor syntax or semantic error.
8 marks	Response about half-right Partially correct implementation using solution above or similar but with significant syntax or semantic error.
5 marks	Response with some merit Any other reasonable attempt.

(b)

30 marks

Possible solution:

```
1 # Question 16 (b)
2 # Examination Number:
3 from random import choice
4
5 # Initialises a list called fruits with three elements - apple, cherry and
  orange.
6 fruits = ['apple', 'cherry', 'orange']
7 print("The initial list of fruits is:")
8 print(fruits)
9 print()
10
11 # Prompt the user to enter an additional fruit (e.g. kiwi, lemon etc.) and
  append the value entered to fruits.
12 fruit = input("Enter an additional fruit: ")
13 fruits.append(fruit)
14
15 print("The list of 4 fruits is:")
16 print(fruits)
17 print()
18
19 # Prompt the user to nominate their winning fruit which must be in the
  above list
20 # If the user does not enter a fruit that's in the list the program
  displays an error
21 winning_fruit = input("Nominate your winning fruit: ")
22 while winning_fruit not in fruits:
23     print("ERROR: winning fruit must be one of", fruits)
24     winning_fruit = input("Nominate your winning fruit: ")
25
26 # Display the winning fruit.
27 print("The winning fruit you selected is", winning_fruit)
28 print()
29
30 # Write the code to select three random fruits from fruits.
31 # Compare the selected fruits to the winning fruit entered earlier and ...
32 # ... keep going until all three fruits match the winning fruit.
33 # The program should keep a count of the number of tries taken and
34 # display this with a JACKPOT! message at the end
35 random_fruit_1 = choice(fruits)
36 random_fruit_2 = choice(fruits)
37 random_fruit_3 = choice(fruits)
38
39 count = 1
40 while True:
41     if (random_fruit_1 == random_fruit_2) and \
42         (random_fruit_1 == random_fruit_3) and \
43         (random_fruit_1 == winning_fruit):
44         break
45     random_fruit_1 = choice(fruits)
46     random_fruit_2 = choice(fruits)
47     random_fruit_3 = choice(fruits)
48     count = count + 1
49
50 print("JACKPOT! after", count, "tries")
```

	High level of achievement All of the following implemented correctly and efficiently	Moderate level of achievement Reasonable attempt to implement at least two of each of the following	Low level of achievement Poor attempt to complete any of the following
Programming Standards (10 marks)	<ul style="list-style-type: none"> • Program executes correctly with no syntax or runtime errors • Program meets requirements • Program design is well explained with comments • Meaningful variable/function names (10 marks) 	<ul style="list-style-type: none"> • Program executes correctly with no syntax or runtime errors • Program meets requirements • Program design is well explained with comments • Meaningful variable/function names (7 marks) 	<ul style="list-style-type: none"> • Program executes correctly with no syntax or runtime errors • Program meets requirements • Program design is well explained with comments • Meaningful variable/function names (5 marks)
Program Inputs (5 marks)	<ul style="list-style-type: none"> • Initial list of fruits correctly initialised • User correctly prompted to enter additional fruit and to nominate winning fruit • Program correctly generates three random fruits • Variable initialisation and use of assignment statements (5 marks) 	<ul style="list-style-type: none"> • Initial list of fruits correctly initialised • User correctly prompted to enter additional fruit and to nominate winning fruit • Program correctly generates three random fruits • Variable initialisation and use of assignment statements (4 marks) 	<ul style="list-style-type: none"> • Initial list of fruits correctly initialised • User correctly prompted to enter additional fruit and to nominate winning fruit • Program correctly generates three random fruits • Variable initialisation and use of assignment statements (3 marks)
Program Logic (Processing) (10 marks)	<ul style="list-style-type: none"> • Additional fruit correctly appended to list of fruits • Logic to validate winning fruit • Logic to simulate fruit machine and maintain counter variable (10 marks) 	<ul style="list-style-type: none"> • Additional fruit correctly appended to list of fruits • Logic to validate winning fruit • Logic to simulate fruit machine and maintain counter variable (7 marks) 	<ul style="list-style-type: none"> • Additional fruit correctly appended to list of fruits • Logic to validate winning fruit • Logic to simulate fruit machine and maintain counter variable (5 marks)
Program Outputs (5 marks)	<ul style="list-style-type: none"> • Initial list of fruits displayed • Extended list of four fruits displayed • Winning fruit correctly displayed • Winner! message correctly displayed with counter (5 marks) 	<ul style="list-style-type: none"> • Initial list of fruits displayed • Extended list of four fruits displayed • Winning fruit correctly displayed • Winner! message correctly displayed with counter (4 marks) 	<ul style="list-style-type: none"> • Initial list of fruits displayed • Extended list of four fruits displayed • Winning fruit correctly displayed • Winner! message correctly displayed with counter (3 marks)

Coursework (90 marks in total)	
1. The report	Marks
<ul style="list-style-type: none"> Quality of report website structure and layout. Evidence of adherence to the principles of good user interface design when creating the website. 	4
2. Meeting the brief	
<ul style="list-style-type: none"> Meeting the basic requirements of the brief. Meeting the advanced requirements of the brief. 	24
3. Investigation	
<ul style="list-style-type: none"> Research into the context of the brief, and existing solutions. Conduct research with potential end user(s) to understand their needs. 	10
4. Plan and design	
<ul style="list-style-type: none"> A clear, detailed description of the project. A flowchart/architecture diagram to show how the project will work. A description of the technologies you will use and their role within your project. 	15
5. Create	
<ul style="list-style-type: none"> A progress log covering the key milestones of the development process. Explanation of unit testing applied during development. Explain a problem that was encountered in the development of the project and how it was overcome. An explanation of a piece of code that you have designed and created, which was important in the development of the project. 	25
6. Evaluation	
<ul style="list-style-type: none"> An evaluation of your project based on the requirements set out in the brief. An evaluation of how your project has met the needs of the end user(s). Suggest how you would further improve/iterate this project. 	12
References and summary word count	
<ul style="list-style-type: none"> You must also include references and/or a bibliography. Include a summary of the word count of the report, including the total word count. 	0

Higher grade	Ordinary grade	Reference Mark	Higher Mark	Ordinary Mark
1		81 – 90	81 – 90	90
2		72 – 80	72 – 80	90
3		63 – 71	63 – 71	90
4		54 – 62	54 – 62	90
5	1	45 – 53	45 – 53	81 – 90
6	2	36 – 44	36 – 44	72 – 80
7	3	27 – 35	27 – 35	63 – 71
8	4	23 – 26	23 – 26	54 – 62
	5	18 – 22	18 – 22	45 – 53
	6	14 – 17	14 – 17	36 – 44
	7	9 – 13	9 – 13	27 – 35
	8	0 – 8	0 – 8	0 – 26

COURSEWORK – conversion from reference mark to Ordinary-level mark

For Ordinary-level candidates, the final mark is found from the reference mark as follows:

- If the reference mark is 54 or more the final mark is 90.
- If the reference mark is at least 27 but less than 54, then add 36 to the reference mark to get the final mark.
- If the reference is at least 1 but less than 27, then double the reference mark and add 9 to get the final mark.
- If the reference mark is 0 the final mark is 0

Reference Mark	Conversion
54 or more	Award 90 marks
27 – 53	Add 36 marks
1 - 26	Multiply the reference mark by 2 and add 9 marks
0	0

