OCR A Level Computer Science

Summer Homework Extended Writing Workbook

Name	
Class	
Teacher	
Target grade	

Instructions

Answer each extended writing question in the lined answer space provided. Use accurate terminology, apply your answer to the scenario and include evaluation where the question asks you to discuss, compare or justify.

The model answers and mark schemes are included at the back. Complete the questions first before using them to improve your response.

If you finish this early then complete this online python course to support your course work!

https://www.youtube.com/watch?v=rfscVS0vtbw

Assessment objectives

AO	What students need to demonstrate
AO1	Knowledge and understanding of computer science concepts, terminology and principles.
AO2	Application of knowledge and understanding to the specific scenario in the question.
AO3	Analysis, evaluation and reasoned judgement, usually required in discuss, compare and justify questions.

Contents

Paper 1: Computer Systems

Paper 2: Algorithms and Programming

Paper 1: Computer Systems

Extended writing practice questions

Paper	Paper 1: Computer Systems
Question	1. Processor performance and architecture
Marks	12
Assessment objectives	AO1, AO2, AO3

A school is replacing older desktop computers used for video editing, programming and running virtual machines.

Discuss the factors that affect processor performance and justify which processor features would be most important for this school.

In your answer, you should refer to clock speed, number of cores, cache, word size, pipelining and parallel processing.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 1: Computer Systems Question 1

Topic: Processor performance and architecture Marks: 12

Paper	Paper 1: Computer Systems
Question	2. CISC and RISC processors
Marks	9
Assessment objectives	AO1, AO2, AO3

A company is designing a new low power tablet device for students. The device must have long battery life and perform common tasks such as web browsing, note taking and video streaming.

Compare CISC and RISC processors and justify which type of processor would be more suitable for this device.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 1: Computer Systems Question 2

Topic: CISC and RISC processors Marks: 9

Paper	Paper 1: Computer Systems
Question	3. Operating systems and virtual machines
Marks	12
Assessment objectives	AO1, AO2, AO3

A software development company allows developers to use virtual machines to test applications on different operating systems.

Discuss the role of the operating system and explain the benefits and limitations of using virtual machines in this scenario.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 1: Computer Systems Question 3

Topic: Operating systems and virtual machines Marks: 12

Paper	Paper 1: Computer Systems
Question	4. Compression, encryption and hashing
Marks	12
Assessment objectives	AO1, AO2, AO3

A hospital stores patient records, medical images and login details on its computer systems.

Discuss how compression, encryption and hashing could be used by the hospital. Evaluate the importance of each technique.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 1: Computer Systems Question 4

Topic: Compression, encryption and hashing Marks: 12

Paper	Paper 1: Computer Systems
Question	5. Databases and normalisation
Marks	9
Assessment objectives	AO1, AO2, AO3

A large online retailer stores customer, order and product data in a relational database.

Discuss the benefits of using a relational database and explain why normalisation is important when designing the database.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 1: Computer Systems Question 5

Topic: Databases and normalisation Marks: 9

Paper	Paper 1: Computer Systems
Question	6. Networks and protocols
Marks	12
Assessment objectives	AO1, AO2, AO3

A business has offices in London, Manchester and Birmingham. Staff need to share files, access cloud services and communicate using video calls.

Discuss the hardware, protocols and network services required to support communication between the offices.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 1: Computer Systems Question 6

Topic: Networks and protocols Marks: 12

Paper	Paper 1: Computer Systems
Question	7. Web technologies
Marks	9
Assessment objectives	AO1, AO2, AO3

An online learning platform allows students to log in, watch videos, complete quizzes and save their progress.

Discuss how client side and server side processing are used by the platform. In your answer, refer to HTML, CSS, JavaScript, HTTP and databases.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 1: Computer Systems Question 7

Topic: Web technologies Marks: 9

Paper	Paper 1: Computer Systems
Question	8. Data representation and floating point
Marks	9
Assessment objectives	AO1, AO2, AO3

A scientific simulation program stores very large and very small numbers using floating point representation.

Explain how floating point numbers are represented and discuss the trade off between range, precision and accuracy.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 1: Computer Systems Question 8

Topic: Data representation and floating point Marks: 9

Paper	Paper 1: Computer Systems
Question	9. Data structures
Marks	12
Assessment objectives	AO1, AO2, AO3

A music streaming service stores playlists, recently played songs and search results.

Discuss how arrays, linked lists, stacks, queues and hash tables could be used within the system. Justify which data structure would be most suitable for each task.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 1: Computer Systems Question 9

Topic: Data structures Marks: 12

Paper	Paper 1: Computer Systems
Question	10. Legal, moral and ethical issues
Marks	12
Assessment objectives	AO1, AO2, AO3

A company uses artificial intelligence to analyse customer data and make automated decisions about pricing, advertising and account restrictions.

Discuss the legal, moral and ethical issues raised by this use of artificial intelligence.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 1: Computer Systems Question 10

Topic: Legal, moral and ethical issues Marks: 12

Paper 2: Algorithms and Programming

Extended writing practice questions

Paper	Paper 2: Algorithms and Programming
Question	1. Computational thinking
Marks	12
Assessment objectives	AO1, AO2, AO3

A delivery company is developing software to plan routes for drivers across a city.

Discuss how abstraction, decomposition, algorithmic thinking and thinking ahead could be used when designing this system.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 2: Algorithms and Programming Question 1

Topic: Computational thinking Marks: 12

Paper	Paper 2: Algorithms and Programming
Question	2. Searching algorithms
Marks	9
Assessment objectives	AO1, AO2, AO3

A library system stores thousands of book records sorted by ISBN.

Compare linear search and binary search. Justify which search algorithm would be more suitable for this system.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 2: Algorithms and Programming Question 2

Topic: Searching algorithms Marks: 9

Paper	Paper 2: Algorithms and Programming
Question	3. Sorting algorithms
Marks	12
Assessment objectives	AO1, AO2, AO3

A school stores student results in an array and needs to sort them into ascending order.

Compare bubble sort, insertion sort and merge sort. Discuss their time complexities and justify which algorithm would be most suitable as the number of records increases.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 2: Algorithms and Programming Question 3

Topic: Sorting algorithms Marks: 12

Paper	Paper 2: Algorithms and Programming
Question	4. Big O complexity
Marks	9
Assessment objectives	AO1, AO2, AO3

A programmer writes two algorithms to process customer orders. One algorithm has time complexity O(n) and the other has time complexity O(n^2).

Explain what is meant by time complexity and space complexity. Discuss why Big O notation is useful when comparing algorithms.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 2: Algorithms and Programming Question 4

Topic: Big O complexity Marks: 9

Paper	Paper 2: Algorithms and Programming
Question	5. Recursion
Marks	9
Assessment objectives	AO1, AO2, AO3

A programmer uses recursion to calculate values in a sequence.

Explain how recursion works and discuss the benefits and limitations of using recursion instead of iteration.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 2: Algorithms and Programming Question 5

Topic: Recursion Marks: 9

Paper	Paper 2: Algorithms and Programming
Question	6. Graphs and pathfinding
Marks	12
Assessment objectives	AO1, AO2, AO3

A navigation app models roads as a graph. Junctions are represented as nodes and roads are represented as edges.

Discuss how graphs can be represented in computer memory and explain how a shortest path algorithm could be used by the navigation app.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 2: Algorithms and Programming Question 6

Topic: Graphs and pathfinding Marks: 12

Paper	Paper 2: Algorithms and Programming
Question	7. Stacks and queues
Marks	9
Assessment objectives	AO1, AO2, AO3

A processor uses interrupts while a printer uses a print queue.

Explain how stacks and queues work. Discuss why each data structure is suitable for the examples given.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 2: Algorithms and Programming Question 7

Topic: Stacks and queues Marks: 9

Paper	Paper 2: Algorithms and Programming
Question	8. Object oriented programming
Marks	12
Assessment objectives	AO1, AO2, AO3

A game is being developed using object oriented programming. The game includes players, enemies, weapons and levels.

Discuss how classes, objects, encapsulation, inheritance and polymorphism could be used in the design of the game.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 2: Algorithms and Programming Question 8

Topic: Object oriented programming Marks: 12

Paper	Paper 2: Algorithms and Programming
Question	9. Programming paradigms
Marks	12
Assessment objectives	AO1, AO2, AO3

A software company is deciding whether to use procedural programming, object oriented programming or functional programming for a new project.

Compare these programming paradigms and justify which would be most suitable for a large project developed by a team.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 2: Algorithms and Programming Question 9

Topic: Programming paradigms Marks: 12

Paper	Paper 2: Algorithms and Programming
Question	10. Concurrent processing
Marks	12
Assessment objectives	AO1, AO2, AO3

A ticket booking website must allow many users to search for seats, reserve tickets and make payments at the same time.

Discuss the benefits and problems of concurrent processing in this system. In your answer, refer to race conditions, deadlock and the need for synchronisation.

Write your answer on the lined page that follows. Aim to cover AO1 knowledge, AO2 application and AO3 evaluation where appropriate.

Answer space: Paper 2: Algorithms and Programming Question 10

Topic: Concurrent processing Marks: 12

Mark Schemes and Model Answers

Use this section after completing the questions. The mark schemes show the main points students could include. The model answers demonstrate the level of depth and structure expected for high marks.

Paper 1: Computer Systems Question 1: Processor performance and architecture

Marks: 12 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Accurate knowledge of clock speed, cores, cache, word size, pipelining and parallel processing.	Use accurate technical terminology and clear definitions.
AO2	Applies these factors to video editing, programming, virtual machines and school use.	Apply points directly to the scenario rather than writing generic theory.
AO3	Justifies the most important features and recognises limitations such as heat, branching and partial parallelisation.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Processor performance is affected by several hardware features. Clock speed controls how many cycles the CPU can perform per second, while the number of cores affects how many instructions or threads can be processed at the same time. Cache is a small, fast memory close to the CPU that stores frequently used instructions and data. Word size affects how much data can be processed in one operation and the amount of memory that can be addressed. Pipelining improves throughput by allowing different stages of the fetch, decode, execute cycle to overlap. Parallel processing allows several processors or cores to work on different parts of a problem at the same time.

AO2

In this school, video editing and virtual machines are demanding tasks. A high clock speed would help with tasks that rely on single threaded performance, such as some parts of programming and general system responsiveness. Multiple cores would be important because virtual machines, video rendering and multitasking can divide work across cores. A larger cache would reduce the need to fetch data from slower main memory, improving performance when repeatedly accessing instructions or data. A larger word size, such as 64 bit, would allow the systems to use more RAM, which is important for virtual machines and media editing.

AO3

The most important features would be multiple cores, sufficient cache and 64 bit architecture, because the school needs to run several demanding tasks at once. Clock speed is still important, but increasing clock speed alone has physical limits due to heat and power consumption. Pipelining improves throughput but can be affected by branching. Parallel processing is useful for video rendering and virtualisation, but not all tasks can be fully parallelised. Therefore, a balanced processor with several cores, high cache and strong single core performance would be the best choice.

Examiner comments

A top answer explains several processor features, applies them directly to the school scenario and reaches a balanced judgement rather than simply listing factors.

Paper 1: Computer Systems Question 2: CISC and RISC processors

Marks: 9 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Defines and contrasts CISC and RISC instruction sets and typical execution characteristics.	Use accurate technical terminology and clear definitions.
AO2	Links processor type to low power use, battery life, heat and common student tasks.	Apply points directly to the scenario rather than writing generic theory.
AO3	Justifies RISC for the scenario while recognising where CISC may still be useful.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

CISC processors have a large instruction set with more complex instructions. A single CISC instruction may carry out several low level operations. RISC processors have a smaller instruction set with simpler instructions that are usually executed quickly, often in one clock cycle. RISC designs usually use many registers and are well suited to pipelining.

AO2

For a tablet, battery life and low power consumption are very important. A RISC processor is suitable because its simpler instructions and efficient pipeline can reduce power use and heat output. It can still perform common student tasks such as browsing, note taking and video streaming effectively. A CISC processor may be powerful and compatible with a wide range of desktop software, but it may use more power and generate more heat, which is less suitable for a portable device.

AO3

RISC would generally be the better choice for this tablet because efficiency and battery life are more important than maximum desktop level performance. CISC may be preferable in some laptop or desktop environments where legacy software support and complex processing are important. However, for a student tablet, the lower power use and efficient execution of RISC make it the more appropriate option.

Examiner comments

This reaches the top band because it does not simply state that RISC is faster. It links architectural differences to the needs of a low power tablet.

Paper 1: Computer Systems Question 3: Operating systems and virtual machines

Marks: 12 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Explains operating system functions and what a virtual machine is.	Use accurate technical terminology and clear definitions.
AO2	Applies benefits to software testing, multiple operating systems, snapshots and isolation.	Apply points directly to the scenario rather than writing generic theory.
AO3	Evaluates limitations including resource overhead, performance and hardware differences.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

An operating system manages the hardware and software resources of a computer. It manages memory, processor scheduling, files, input and output devices, user interfaces and security. A virtual machine is a software based emulation of a computer system that allows an operating system and applications to run inside a controlled environment on a host machine.

AO2

For the development company, virtual machines allow developers to test software on different operating systems without needing separate physical computers. This can reduce cost and save space. Virtual machines can be reset to a previous state using snapshots, which is useful when testing risky software changes. They also allow isolation, so a fault or malware infection in one virtual machine is less likely to affect the host system or other projects.

AO3

Virtual machines are highly useful for testing because they make the development process flexible and repeatable. However, they use additional resources because both the host and guest operating systems require memory, storage and processor time. Performance may be slower than running directly on physical hardware, especially for graphics intensive or hardware dependent software. Some device drivers and hardware features may not behave exactly the same in a virtual environment. Overall, virtual machines are appropriate for testing across operating systems, but final testing may still need to be carried out on real target hardware.

Examiner comments

A strong answer is balanced. It explains why virtual machines are useful, but also explains why they cannot always replace real hardware testing.

Paper 1: Computer Systems Question 4: Compression, encryption and hashing

Marks: 12 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Defines compression, encryption and hashing accurately.	Use accurate technical terminology and clear definitions.
AO2	Applies each technique to patient records, medical images, passwords and file integrity.	Apply points directly to the scenario rather than writing generic theory.
AO3	Prioritises techniques and explains risks, especially confidentiality and clinical accuracy.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Compression reduces the size of files. Lossless compression allows the original data to be restored exactly, while lossy compression permanently removes data to reduce file size further. Encryption changes readable data into ciphertext using a key so that unauthorised users cannot understand it. Hashing uses an algorithm to generate a fixed length value from data and is commonly used to store passwords securely or check data integrity.

AO2

The hospital could use lossless compression for patient records so that no information is lost. Medical images may also need lossless compression where diagnostic accuracy matters, although lossy compression may be acceptable for non clinical copies. Encryption should be used for stored patient records and for data sent across networks, because medical information is highly sensitive. Hashing should be used for passwords so the original password is not stored directly. Hash values can also be used to check whether a medical file has been changed.

AO3

Encryption is the most important for protecting confidentiality because a breach of patient data could cause serious harm and legal consequences. Hashing is essential for authentication and integrity, but it does not keep ordinary patient records secret because hashing is one way and not suitable for reading data later. Compression is useful for reducing storage costs and speeding up transfer, but it must not reduce the accuracy of clinical information. Therefore, all three are important, but encryption and hashing are more critical for security, while compression is mainly important for efficiency.

Examiner comments

This answer is top band because it avoids treating the three techniques as interchangeable and explains their different purposes in the hospital context.

Paper 1: Computer Systems Question 5: Databases and normalisation

Marks: 9 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Explains relational tables, records, fields, keys and normalisation.	Use accurate technical terminology and clear definitions.
AO2	Applies database design to customers, orders, products and stock.	Apply points directly to the scenario rather than writing generic theory.
AO3	Evaluates benefits and possible trade offs such as joins and performance.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

A relational database stores data in tables made up of records and fields. Tables can be linked using primary keys and foreign keys. Normalisation is the process of organising data to reduce redundancy and improve data integrity. It involves separating data into appropriate tables and removing repeating groups and unnecessary duplication.

AO2

For an online retailer, customer, order and product data can be stored in separate related tables. This means one customer can have many orders and each order can contain many products without storing the same customer or product details repeatedly. Queries can be used to find orders, update stock and generate reports. Normalisation reduces the chance of inconsistent data, such as the same product having different prices stored in different places.

AO3

A relational database is suitable because the retailer needs structured data, reliable updates and relationships between entities. Normalisation improves integrity and reduces wasted storage, but too much normalisation can make queries more complex and may reduce performance because more joins are required. Overall, a well normalised relational design is appropriate, with careful indexing and design decisions to maintain performance.

Examiner comments

The answer earns high marks by linking normalisation to data integrity rather than only saying it saves space.

Paper 1: Computer Systems Question 6: Networks and protocols

Marks: 12 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Identifies relevant hardware, protocols and services.	Use accurate technical terminology and clear definitions.
AO2	Applies them to multiple offices, file sharing, cloud access and video communication.	Apply points directly to the scenario rather than writing generic theory.
AO3	Evaluates cost, security, reliability, bandwidth and cloud dependency.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Networks require hardware such as switches, routers, wireless access points, servers, network interface cards and cabling. Protocols define rules for communication. TCP/IP is used for addressing and routing data across networks, DNS resolves domain names to IP addresses, HTTP or HTTPS is used for web services, SMTP and IMAP may be used for email, and VoIP protocols can support voice or video communication. Network services may include file sharing, authentication, DHCP and cloud services.

AO2

The business would need routers to connect each office to the internet and to each other, and switches to connect devices within each office. A VPN could provide secure communication between sites. DNS would allow users to access cloud services and internal systems by name rather than IP address. DHCP could assign IP addresses automatically. HTTPS would protect access to cloud applications. Video calls require sufficient bandwidth, low latency and reliable network equipment.

AO3

The most suitable approach would be a secure wide area network using reliable internet connections, VPNs or dedicated links, with centralised cloud services where appropriate. Cloud file sharing can reduce the need for maintaining local servers, but the business becomes dependent on internet access and provider reliability. Video calls are sensitive to latency and packet loss, so quality of service may be required. Security is critical because data is travelling between sites. The solution must balance cost, reliability, performance and security.

Examiner comments

A top response is not just a list of networking terms. It explains how the components work together to meet the needs of the business.

Paper 1: Computer Systems Question 7: Web technologies

Marks: 9 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Explains client side and server side processing and relevant web technologies.	Use accurate technical terminology and clear definitions.
AO2	Applies technologies to login, videos, quizzes and saving progress.	Apply points directly to the scenario rather than writing generic theory.
AO3	Evaluates responsiveness, security, server load and reliability.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Client side processing takes place in the user browser, while server side processing takes place on the web server. HTML defines the structure of web pages, CSS controls presentation, and JavaScript can provide interactivity in the browser. HTTP or HTTPS is used for communication between the client and server. Databases store structured data that can be retrieved and updated by server side code.

AO2

For the learning platform, HTML and CSS display pages, menus, videos and quiz layouts. JavaScript can validate quiz answers, update the page dynamically and improve interactivity without reloading the whole page. When a student logs in or saves progress, data must be sent to the server using HTTPS. The server checks credentials, retrieves lesson content and writes quiz scores or progress to a database.

AO3

Client side processing improves responsiveness and reduces server load, but it cannot be trusted for security because users can inspect or modify client side code. Server side processing is better for authentication, storing progress and protecting data, but it increases server workload and requires reliable connectivity. Therefore, the best design uses client side processing for presentation and interaction, and server side processing for secure data handling and database updates.

Examiner comments

This answer is high quality because it assigns each technology a clear role and explains why security critical work belongs on the server.

Paper 1: Computer Systems Question 8: Data representation and floating point

Marks: 9 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Explains mantissa, exponent, binary point and normalisation.	Use accurate technical terminology and clear definitions.
AO2	Applies range and precision to scientific simulation values.	Apply points directly to the scenario rather than writing generic theory.
AO3	Evaluates the trade off between exponent bits, mantissa bits and rounding error.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Floating point representation stores a number using a mantissa and an exponent. The mantissa stores the significant digits and the exponent stores the scale or position of the binary point. This allows very large and very small values to be represented using a fixed number of bits. Normalisation is used so that numbers are stored in a consistent form and precision is used efficiently.

AO2

A scientific simulation may need to store very small measurements and very large values in the same program. Increasing the number of bits used for the exponent increases the range of values that can be represented. Increasing the number of bits used for the mantissa increases precision because more significant digits can be stored. However, the total number of bits is fixed, so increasing range may reduce precision.

AO3

Floating point is suitable for scientific simulations because it can represent a wide range of values, but it can introduce rounding errors because not all real numbers can be represented exactly in binary. This may affect accuracy, especially after many repeated calculations. The best allocation of bits depends on the problem. A simulation needing extreme values may prioritise exponent bits, while a calculation requiring high accuracy should prioritise mantissa bits.

Examiner comments

A full mark answer must go beyond definitions and discuss the consequences of fixed bit allocation.

Paper 1: Computer Systems Question 9: Data structures

Marks: 12 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Describes arrays, linked lists, stacks, queues and hash tables accurately.	Use accurate technical terminology and clear definitions.
AO2	Applies each structure to playlists, recently played items, playback queues and search.	Apply points directly to the scenario rather than writing generic theory.
AO3	Justifies suitability using access patterns, insertion, deletion, lookup and memory considerations.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

An array stores items in contiguous memory and supports direct access using an index. A linked list stores nodes with data and pointers, making insertions and deletions easier when the position is known. A stack is last in first out, while a queue is first in first out. A hash table uses a hashing function to map a key to a storage location, allowing fast lookup in many cases.

AO2

A playlist could be stored in an array if the order is fixed and direct access to a track number is needed. A linked list may be better if users frequently insert or remove songs from the middle of a playlist. Recently played songs could use a stack if the service needs to return to the most recent track first. A queue is suitable for tracks waiting to play next because the first track added should usually be played first. A hash table is suitable for finding songs, artists or albums quickly using a key such as track ID.

AO3

No single data structure is best for every task. Arrays are efficient for indexing but less flexible for frequent insertion. Linked lists are flexible but require extra memory for pointers and do not allow direct indexing. Stacks and queues are ideal where the access pattern is fixed, but they are not suitable for general searching. Hash tables are excellent for fast lookup but can suffer from collisions and do not naturally maintain order. Therefore, the streaming service should use different data structures for different parts of the system.

Examiner comments

This answer reaches top band because it selects structures based on the task rather than claiming one structure is universally best.

Paper 1: Computer Systems Question 10: Legal, moral and ethical issues

Marks: 12 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Shows understanding of AI, customer data and automated decisions.	Use accurate technical terminology and clear definitions.
AO2	Applies legal, moral and ethical issues to pricing, adverts and account restrictions.	Apply points directly to the scenario rather than writing generic theory.
AO3	Evaluates benefits and risks and proposes appropriate safeguards.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Artificial intelligence uses computer systems to perform tasks that normally require human intelligence, such as pattern recognition, prediction and decision making. Customer data may include personal information, behavioural data and purchase history. Automated decision making can affect what customers see, what they pay and whether they are allowed to use an account.

AO2

Legally, the company must follow data protection law by processing personal data fairly, securely and for a clear purpose. Customers may need to be informed about how their data is used and whether decisions are automated. Ethically, there is a risk of unfair pricing, discrimination or bias if the AI has been trained on unrepresentative or biased data. Customers may be targeted with manipulative adverts or have accounts restricted without understanding why.

AO3

AI could benefit the company and customers by detecting fraud, personalising services and improving efficiency. However, decisions that affect prices or account restrictions should not be left entirely unexplained. The company should use transparency, human review, bias testing, secure storage and clear appeal processes. The approach is acceptable only if customers are treated fairly and legal responsibilities are met.

Examiner comments

A top answer gives a balanced discussion. It recognises benefits of AI but explains why fairness, transparency and accountability are essential.

Paper 2: Algorithms and Programming Question 1: Computational thinking

Marks: 12 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Defines abstraction, decomposition, algorithmic thinking and thinking ahead.	Use accurate technical terminology and clear definitions.
AO2	Applies each concept to route planning, traffic, drivers and delivery addresses.	Apply points directly to the scenario rather than writing generic theory.
AO3	Evaluates the benefits and risks of simplifying and modularising the problem.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Abstraction is the process of removing unnecessary detail and focusing on the important features of a problem. Decomposition breaks a complex problem into smaller subproblems. Algorithmic thinking involves designing step by step methods to solve a problem. Thinking ahead involves considering future states, possible consequences and how choices affect later decisions.

AO2

For route planning, abstraction could represent roads as edges and junctions as nodes, ignoring unnecessary details such as shop names or building colours. Decomposition could separate the system into modules for collecting delivery addresses, calculating distances, checking traffic and assigning routes to drivers. Algorithmic thinking would be used to design a method for finding efficient routes. Thinking ahead would help the system consider delays, road closures or the impact of assigning one driver to a particular route.

AO3

These techniques are valuable because the route planning problem is too complex to solve as one whole task. Abstraction makes the problem manageable, but if too much detail is removed the route may become unrealistic. Decomposition supports teamwork and testing, but the modules must integrate correctly. Thinking ahead improves decisions but can increase complexity. A successful system should use all four techniques together to produce routes that are efficient, realistic and adaptable.

Examiner comments

The best answers use the scenario throughout and explain how computational thinking affects the design, not just the final code.

Paper 2: Algorithms and Programming Question 2: Searching algorithms

Marks: 9 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Describes linear and binary search and gives relevant complexity.	Use accurate technical terminology and clear definitions.
AO2	Applies the algorithms to sorted ISBN records and large data size.	Apply points directly to the scenario rather than writing generic theory.
AO3	Justifies binary search while recognising when linear search may be acceptable.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Linear search checks each item in a list one at a time until the target is found or the end of the list is reached. It can be used on unsorted data and has worst case time complexity O(n). Binary search works on sorted data by comparing the target with the middle item and repeatedly discarding half of the remaining search space. It has worst case time complexity O(log n).

AO2

The library stores thousands of book records sorted by ISBN, so binary search can be used. If searching for a specific ISBN, binary search would find the record much more quickly than checking every book one at a time. Linear search would still work, but it would become inefficient as the number of records increases.

AO3

Binary search is the better choice because the data is already sorted and the data set is large. Its O(log n) complexity scales much better than O(n). Linear search may be simpler and may be useful if the data is unsorted or very small, but in this scenario binary search is more appropriate.

Examiner comments

This answer is full mark because the judgement is based on the sorted nature of the data and the size of the data set.

Paper 2: Algorithms and Programming Question 3: Sorting algorithms

Marks: 12 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Explains how bubble, insertion and merge sort work and states relevant complexities.	Use accurate technical terminology and clear definitions.
AO2	Applies complexity to student results and increasing number of records.	Apply points directly to the scenario rather than writing generic theory.
AO3	Justifies merge sort for larger data while considering memory and small data cases.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Bubble sort repeatedly compares neighbouring items and swaps them if they are in the wrong order. Insertion sort builds a sorted section by inserting each new item into the correct position. Merge sort uses divide and conquer by splitting the list into smaller lists, sorting them and merging them back together. Bubble sort and insertion sort have worst case time complexity O(n^2), while merge sort has time complexity O(n log n). Merge sort usually requires additional memory, while bubble sort and insertion sort can be in place.

AO2

For a small number of student results, bubble sort or insertion sort may be acceptable because they are simple to implement. Insertion sort may perform well if the results are already nearly sorted. However, as the number of records increases, O(n^2) algorithms become inefficient because the number of comparisons grows rapidly. Merge sort would handle larger arrays of results more effectively because its O(n log n) growth is much slower.

AO3

Merge sort is the best choice as the number of records increases because it scales better than bubble sort or insertion sort. The disadvantage is that it is more complex and may require extra memory. If the data set is very small or nearly sorted, insertion sort could be a reasonable choice. Bubble sort is generally the least suitable because it performs many unnecessary swaps and comparisons. Overall, merge sort is preferable for larger data sets.

Examiner comments

A top response compares algorithms rather than describing only one. It also recognises that Big O is not the only factor, especially for small or nearly sorted data.

Paper 2: Algorithms and Programming Question 4: Big O complexity

Marks: 9 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Defines time complexity, space complexity and Big O.	Use accurate technical terminology and clear definitions.
AO2	Applies O(n) and O(n^2) to increasing customer orders.	Apply points directly to the scenario rather than writing generic theory.
AO3	Evaluates the usefulness and limitations of Big O notation.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Time complexity describes how the running time of an algorithm grows as the input size increases. Space complexity describes how the amount of memory used by an algorithm grows as the input size increases. Big O notation gives the order of growth and focuses on scalability rather than exact execution time.

AO2

For processing customer orders, an O(n) algorithm grows in proportion to the number of orders. If the number of orders doubles, the amount of work approximately doubles. An O(n^2) algorithm grows much faster. If the number of orders doubles, the work may become around four times greater. This matters for a business because order volumes may increase over time.

AO3

Big O is useful because it allows algorithms to be compared independently of the specific hardware, programming language or exact implementation. However, it does not give the actual running time and does not always show performance for small inputs. Constant factors and implementation quality still matter. Even so, for large data sets, Big O is valuable because it shows which algorithms are likely to scale well.

Examiner comments

The answer is strong because it explains both the value and the limitations of complexity analysis.

Paper 2: Algorithms and Programming Question 5: Recursion

Marks: 9 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Explains recursive calls, base case, recursive case and call stack.	Use accurate technical terminology and clear definitions.
AO2	Applies recursion to sequences and repeated calculations.	Apply points directly to the scenario rather than writing generic theory.
AO3	Evaluates clarity, memory use, stack overflow and efficiency compared with iteration.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Recursion occurs when a subroutine calls itself. A recursive algorithm must have a base case that stops the recursion and a recursive case that moves the problem closer to the base case. Each call is placed on the call stack until the base case is reached, then the results are returned back through the stack.

AO2

For a sequence such as factorial or Fibonacci, recursion can express the problem naturally because each value may be defined in terms of previous values. The programmer can write code that closely matches the mathematical definition. However, if the recursive function makes many repeated calls, such as a naive Fibonacci solution, it may be inefficient.

AO3

Recursion can make some algorithms clearer, especially those based on divide and conquer or naturally recursive structures such as trees. However, it can use more memory because each call needs a stack frame. If there is no correct base case, infinite recursion can occur and cause a stack overflow. Iteration is often more efficient for simple repeated processes, while recursion is better when it improves clarity or matches the problem structure.

Examiner comments

High scoring answers must explain the base case and evaluate recursion against iteration rather than simply saying recursion repeats.

Paper 2: Algorithms and Programming Question 6: Graphs and pathfinding

Marks: 12 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Explains graphs, nodes, edges, weights and memory representations.	Use accurate technical terminology and clear definitions.
AO2	Applies adjacency matrix, adjacency list and shortest path to road networks.	Apply points directly to the scenario rather than writing generic theory.
AO3	Justifies representation choices and evaluates real time accuracy and recalculation.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

A graph consists of vertices or nodes connected by edges. Edges may be weighted to represent values such as distance or travel time, and directed if movement is only allowed in one direction. Graphs can be represented using an adjacency matrix, where a two dimensional array stores connections between nodes, or an adjacency list, where each node stores a list of connected nodes.

AO2

In a navigation app, junctions can be stored as nodes and roads as weighted edges. The weight could represent distance, estimated journey time or traffic delay. An adjacency matrix may be quick to check whether two junctions are directly connected, but it can waste memory if most junctions are connected to only a few roads. An adjacency list is more memory efficient for road networks because each junction usually connects to a limited number of roads. A shortest path algorithm such as Dijkstra can repeatedly select the current lowest cost route and update distances to neighbouring nodes.

AO3

An adjacency list is likely to be more suitable for a large city road network because the graph is sparse. A shortest path algorithm is useful because it can find an efficient route, but the quality of the route depends on accurate weights. If weights do not include live traffic, the route may not be realistic. The app may also need to recalculate routes when roads close or traffic changes. Therefore, graph representation and pathfinding are appropriate, but real time data is needed for effective navigation.

Examiner comments

This answer is top band because it compares representations and links weighted graphs directly to route planning.

Paper 2: Algorithms and Programming Question 7: Stacks and queues

Marks: 9 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Defines stack operations and queue operations.	Use accurate technical terminology and clear definitions.
AO2	Applies stack to interrupts and queue to print jobs.	Apply points directly to the scenario rather than writing generic theory.
AO3	Justifies suitability by comparing access patterns and consequences of using the wrong structure.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

A stack is a last in first out data structure. Items are pushed onto the top of the stack and popped from the top. A queue is a first in first out data structure. Items are enqueued at the rear and dequeued from the front.

AO2

A stack is suitable for interrupts because the current processor state can be pushed onto the stack when an interrupt occurs. After the interrupt service routine has completed, the previous state can be popped and execution can continue from where it left off. A print queue is suitable for printer jobs because documents should normally be printed in the order they were submitted, so the first job added is the first job printed.

AO3

Stacks and queues are suitable because their access rules match the problem. A stack supports returning to the most recent interrupted task, while a queue gives fair first come first served processing. A stack would not be suitable for print jobs because the most recent document would print first, which would be unfair. A queue would not be suitable for nested interrupts because it would not return control in the correct reverse order.

Examiner comments

A full mark answer clearly links last in first out and first in first out to the scenario.

Paper 2: Algorithms and Programming Question 8: Object oriented programming

Marks: 12 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Defines classes, objects, encapsulation, inheritance and polymorphism.	Use accurate technical terminology and clear definitions.
AO2	Applies OOP features to players, enemies, weapons and levels.	Apply points directly to the scenario rather than writing generic theory.
AO3	Evaluates maintainability, reuse, extensibility and possible complexity.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Object oriented programming organises programs around classes and objects. A class is a template that defines attributes and methods. An object is an instance of a class. Encapsulation keeps data and methods together and restricts direct access to internal data. Inheritance allows one class to inherit attributes and methods from another. Polymorphism allows different classes to respond to the same method call in different ways.

AO2

In the game, a Player class could store health, score and position, with methods such as move or attack. Enemy objects could be created from an Enemy class. A general Character class could be inherited by Player and Enemy so that shared features such as health and position are not repeated. Encapsulation would prevent external code directly setting health to invalid values. Polymorphism could allow different enemies to use the same attack method name but behave differently, such as a dragon breathing fire and a robot firing lasers.

AO3

OOP is suitable because games contain many related entities with shared and specialised behaviour. It improves code reuse, maintainability and extensibility. However, poor class design can lead to unnecessary complexity, and inheritance should not be overused where composition would be clearer. Overall, OOP is appropriate for this game because it allows players, enemies, weapons and levels to be modelled as interacting objects.

Examiner comments

This response is strong because the examples are specific to the game and each OOP concept is used meaningfully.

Paper 2: Algorithms and Programming Question 9: Programming paradigms

Marks: 12 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Explains procedural, object oriented and functional paradigms.	Use accurate technical terminology and clear definitions.
AO2	Applies each paradigm to a large team project.	Apply points directly to the scenario rather than writing generic theory.
AO3	Justifies OOP while recognising that mixed paradigms may be appropriate.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Procedural programming structures a program as a sequence of procedures or functions that operate on data. Object oriented programming organises code into classes and objects that combine data and methods. Functional programming treats computation as the evaluation of functions, avoids changing state where possible and often uses pure functions.

AO2

For a large team project, procedural programming may be simple and efficient for straightforward tasks, but it can become difficult to manage if the system grows and shared data is modified in many places. OOP can help divide the system into classes and objects, allowing different team members to work on separate components. Functional programming can reduce side effects and make testing easier, but some developers may find it harder to understand and it may not fit all parts of the system.

AO3

OOP would often be the most suitable main paradigm for a large team project because it supports modular design, reuse, encapsulation and maintainability. Procedural programming may still be useful within methods for simple algorithms. Functional techniques may also be useful for data transformation and testing because pure functions are predictable. The best solution may combine paradigms, but OOP is likely to provide the strongest overall structure for a large collaborative project.

Examiner comments

Top answers avoid treating paradigms as isolated definitions. They compare them in relation to teamwork, maintainability and project scale.

Paper 2: Algorithms and Programming Question 10: Concurrent processing

Marks: 12 Assessment objectives: AO1, AO2, AO3

Assessment objective	Indicative content	How to reach top marks
AO1	Defines concurrency, race conditions, deadlock and synchronisation.	Use accurate technical terminology and clear definitions.
AO2	Applies issues to searching, reserving seats and making payments.	Apply points directly to the scenario rather than writing generic theory.
AO3	Evaluates benefits and risks and proposes control mechanisms.	Compare, justify and evaluate. Give a supported judgement where the question asks for one.

Model answer

AO1

Concurrent processing allows multiple tasks to make progress during the same period. This may involve multitasking, multithreading or several processes running on different cores. A race condition occurs when the result depends on the timing of two or more processes accessing shared data. Deadlock occurs when processes wait indefinitely for resources held by each other. Synchronisation is used to control access to shared resources.

AO2

In the ticket booking website, concurrency allows many users to search for seats, reserve tickets and pay at the same time. This improves responsiveness and allows the system to serve many customers. However, a race condition could occur if two users try to reserve the same seat at nearly the same time. Without synchronisation, the system might sell the same ticket twice. Deadlock could occur if one process locks a seat record while waiting for payment data, while another process locks payment data while waiting for the seat record.

AO3

Concurrent processing is necessary for a busy ticket website, but it must be carefully controlled. Locks, transactions and semaphores can prevent inconsistent data, but excessive locking may reduce performance or increase the risk of deadlock. Timeouts and ordered resource locking can reduce deadlock risk. The best approach is to use synchronisation only where shared data is critical, such as seat reservation and payment, while allowing independent searches to run concurrently for performance.

Examiner comments

This is a strong answer because it uses accurate technical terms and applies them to realistic failures in the ticket booking system.