GCSE Computer Science

Mark Scheme

Exam Practice

Topic 3: Computers

This booklet contains ***all*** past questions on this topic

Topic 3: Computers

Students must be familiar with the hardware and software components that make up a computer system.

Subject content	Students should:	
3.1 Hardware	3.1.1	understand the von Neumann stored program concept and the role of main memory (RAM), CPU (control unit, arithmetic logic unit, registers), clock, address bus, data bus, control bus in the fetch-decode-execute cycle
	3.1.2	understand the role of secondary storage and the ways in which data is stored on devices (magnetic, optical, solid state)
	3.1.3	understand the concept of an embedded system and what embedded systems are used for
3.2 Software	3.2.1	understand the purpose and functionality of an operating system (file management, process management, peripheral management, user management)
	3.2.2	understand the purpose and functionality of utility software (file repair, backup, data compression, disk defragmentation, anti-malware)
	3.2.3	understand the importance of developing robust software and methods of identifying vulnerabilities (audit trails, code reviews)
3.3 Programming languages	3.3.1	understand the characteristics and purposes of low-level and high-level programming languages
	3.3.2	understand how an interpreter differs from a compiler in the way it translates high-level code into machine code

(June 2024)

4 Computers

(a) A compiler translates source code to machine code. If the source code is edited, it must be recompiled.

Give **two other** characteristics of a compiler.

(2)

1 .....

2 .....

Award **one** mark for any of the following up to a maximum of **two** marks:

- Translates the whole program in one go (1)
- Errors are reported at the end of translation (1)
- The executable/machine code is architecture specific (1)

(b) Describe how an operating system organises files and folders.

(2)

Award up to **two** marks for a linked description, such as: • Uses a hierarchical/tree structure (1) with a root node/directory (1) • Each position on the tree/path (1) is a directory/sub-directory/folder, or file (1) • Each file has a unique path (1) in relation to the root (1)	For both marks, the expansion must follow/associate with the statement.

(c) Explain **one** way an audit trail helps programmers create robust software.

(2)

Award up to **two** marks for a linked explanation, such as: • An audit trail improves accountability (1) because it keeps track of who makes changes / when changes are made (1) • An audit trail makes going back to an earlier version easier (1) because changes are tracked (1)	For both marks, the expansion must follow/associate with the statement.

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(d) Parking at an airport is controlled by computers.

No paper tickets are issued.

Here is an image of the control system at the exit.

The control system uses sensors, a camera and a database.

The barrier lifts if the parking fee has been paid.

Describe what the system does when the exit sensor is activated by a car driving towards it.

(2)

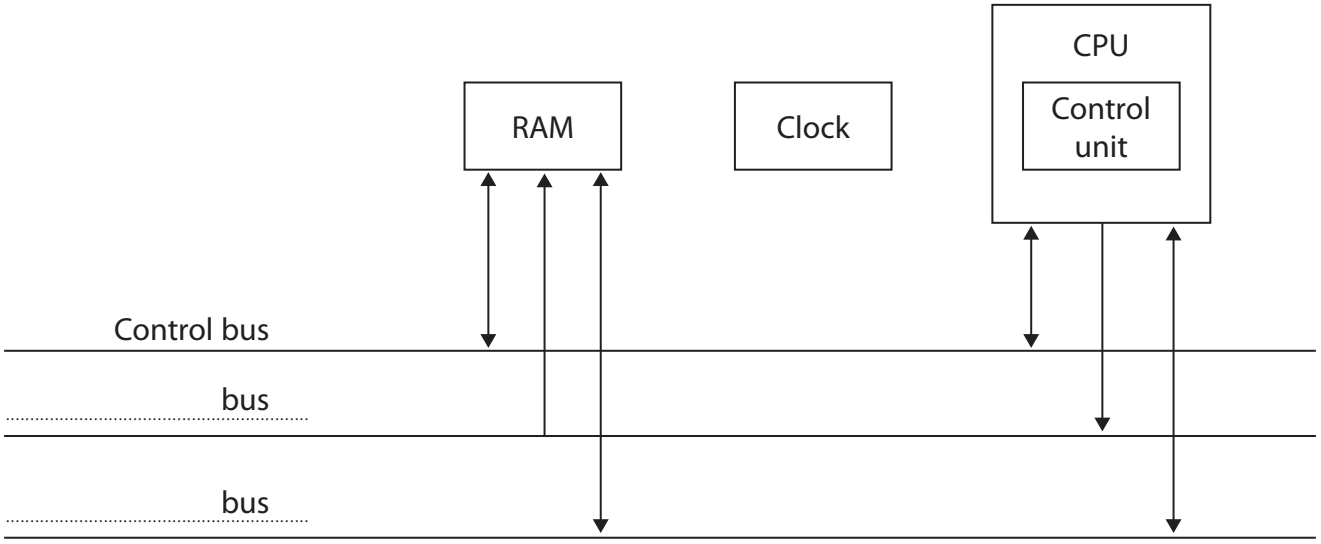
Award up to **two** marks for a linked description, such as: • The **camera** reads the registration plate (1) which is looked up in the **database**/checked in the **database** (to see that the fee has been paid) (1)	For both marks, the expansion must follow/associate with the statement.

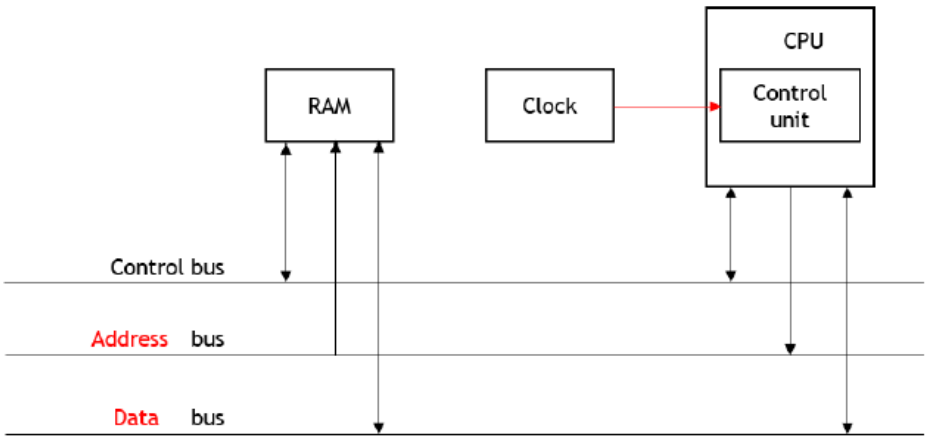
(e) The components of a computer carry out the fetch-decode-execute cycle.

Complete the diagram with:

- the names of **two** buses
- a directional connection from the clock to the correct component.

(3)



Award **one** mark for each of: • Address bus labelled correctly (1) • Data bus labelled correctly (1) • Unidirectional arrow from clock to control unit (1) 	Allow clock connection to CPU box

(f) A company is developing a new smartphone.

The smartphone has built-in devices, including a camera and a sound recorder.

The smartphone has applications, including one to edit pictures, one to translate speech to a text file and one for email.

Discuss the characteristics of high-level and low-level programming languages that make them suitable for developing software for the smartphone.

You should consider:

- the built-in devices
- the applications.

(6)

Indicative content:

Built-in devices

- A low-level language may be used to write the code for the built-in devices.
  - Low-level languages are microprocessor dependent, so are designed to work efficiently with a single chipset, like you find in a phone.
  - Low-level language can manipulate hardware directly, which makes it suitable for writing device drivers, like the receiver for the recorder.
  - Low-level languages can be optimised to reduce execution time, so are good for a real-time system, like focusing the camera.
  - Low-level languages also generate smaller executable code than high-level languages so are good for devices with smaller amounts of RAM, like the phone.
- A high-level language may be used to write the code for the built-in devices.
  - A high-level language compiler must exist to generate code for the phone's chipset.
  - Some high-level languages provide libraries/subprograms which allow direct access to devices.
  - Some high-level languages allow programmers to write in-line assembly code for microchips.
  - Some high-level languages have customisable optimisation options for tuning the efficiency (executing time/resource usage) of programs

Applications:

- A high-level language should be used to write the code for the applications.
  - Any new applications, written in a high-level language, would be portable to a different version of the phone.
  - The email application should be written in a high-level language, because tools are available to make development quick.
  - Any time an application had to interface with the devices, such as sending an email, a library of subprograms would be provided to allow that.
  - High-level languages have libraries of specialised subprograms to complete advanced actions, such as editing an image.

(Total for Question 4 = 17 marks)

Level	Mark	Descriptor
	0	No rewardable content.
Level 1	1–2	Basic, independent points are made, showing elements of understanding of key concepts/principles of computer science. (AO1) The discussion will contain basic information with little linkage between points made or application to the context. (AO2)
Level 2	3–4	Demonstrates adequate understanding of key concepts/principles of computer science. (AO1) The discussion shows some linkages and lines of reasoning with some structure and application to the context. (AO2)
Level 3	5–6	Demonstrates comprehensive understanding of key concepts/principles of computer science to support the discussion being presented. (AO1) The discussion is well developed, with sustained lines of reasoning that are coherent and logically structured, and which clearly apply to the context. (AO2)

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Computers

(a) The CPU contains a number of components.

(i) Complete the table with the correct bus for each role.

(3)

Bus	Role
	Carries a read signal to main memory.
Control (1)	Carries the memory location of a piece of data.
Address (1)	Carries an instruction from main memory to the CPU.
Data (1)	

(ii) Identify the component inside the CPU that stores data.

(1)

☒ **A** Arithmetic logic unit

☒ **B** Clock

☒ **C** Main memory

☒ **D** Register

The only correct answer is D

A is not correct because the ALU carries out operations, rather than stores data
B is not correct because the clock is an electrical signal, it does not store data
C is not correct because main memory is not a component within the CPU

(b) Algorithms can be written in a high-level language.

(i) State what high-level code is translated to.

(1)

Award **one** mark for any of the following:

- Machine code (1)
- Binary (1)
- Object code (1)
- Executable code / an executable (1)

(ii) State **two** methods of source code translation.

(2)

1 2	Award **one** mark for any of the following up to a maximum of **two** marks: • Compile/Compilation (1) • Interpret/Interpretation (1) • Assemble (1)	Allow compiler/compiling, interpreter/interpreting, assembler/assembling

(c) Identify the feature of an optical disc that allows data to be read.

(1)

☒ **A** It is magnetic

☒ **B** It

☒ **C** It

☒ **D** It is volatile

Award **one** mark for any of the following:

- Forms part of another device / system (1)
- Performs a single/dedicated/specific task (1)

(d) Define the term 'embedded system'.

(1)

The only correct answer is C

A is not correct because optical media does not use magnetic charges, unlike a hard disc
B is not correct because the portability does not affect how data is read from it
D is not correct because volatility is not what makes the media readable

(e) A code review is carried out by a programmer or an automated system.

Both methods cost money.

Complete the table with **one other disadvantage** for each method.

(2)

Method of code review	Disadvantage

Guidance

ward **one** mark for each correct cell:

Code review carried out by	Disadvantage
By a programmer	• Adds additional/significant time (to the development cycle) (1) • Introduces human error (1) • Requires an extra person/resource/labour (1) • Requires more experienced programmer (1)
By an automated system	• May not identify all issues (that it is not programmed to find) (1) • May only find well known problems (1)

Do not award cost of buying software or paying additional programmer, as given in the question.

Do not accept:
- 'algorithmic bias'
- 'does not find logic errors'

(f) Identify the purpose of defragmentation software.

(1)

☒ **A** Compressing data

☒ **B** Encrypting data

☒ **C** Organising data

☒ **D** Protecting data

The only correct answer is C

A is not correct because defragmentation software does not compress data
B is not correct because defragmentation software does not encrypt data
D is not correct because defragmentation software does not protect data

(g) One function of an operating system is to manage processes.

(i) Describe **one** way the operating system makes sure each process can use the CPU.

(2)

Award **one** mark for any of the following up to a maximum of **two** marks: • A scheduler/scheduling algorithm controls processes (1) • Each process gets a time slice/small amount of (CPU) time (1) • Processes are held in a data structure (1) • Each process may be held in order / priority (1) • Incomplete processes go to the back of the queue (1)	Allow use of 'program' instead of 'process' Award examples e.g. 'round-robin'. For MP3 – award any example of a data structure e.g. array, list, queue.

(ii) Give **one other** function of an operating system.

(1)

Award **one** mark for any of the following: • File management (1) • Peripheral management (1) • User management (1) • User interface (1)	Allow memory management Allow a specific example, only if it can clearly be attributed to one of the bullets

(Total for Question 1 = 15 marks)

2 Computers

(a) Some low-level programming languages use mnemonics.

(i) State the purpose of a mnemonic.

(1)

Any **one** from: • To represent an instruction/command • To make an instruction/command easy to read/write/learn/remember/understand • An instruction in a set of instructions	Accept generic definitions of mnemonic such as: 'To shorten a piece of information so it is easy to remember.'

(ii) State the type of low-level programming language that uses mnemonics.

(1)

Assembly language

(iii) Mnemonics are one characteristic of some low-level languages.
Describe **one other** characteristic of a low-level language.

(2)

A linked description such as: • They are microprocessor/CPU/machine specific (1) so they can manipulate the hardware directly (1) • They can be highly optimised (1) to make efficient use of the hardware/execute more quickly/use minimal memory (1) • Each line of code (1) is one instruction only (1) Award responses that refer to machine code as a low level language, such as: • **Machine code** is written in binary (1) so instructions can be processed **directly** by the CPU / do not need to be translated (1) Award **one** mark for: • Machine code does not need to be translated (1)	Accept: (Assembly language) instructions are assembled (1) to machine code (1)

(iv) State the name of the high-level programming language translator that executes a line of code immediately after translating it.

(1)

Interpreter

(b) State the **two** items held in RAM according to the von Neumann architecture.

(2)

1 • Data
• Instructions

2

(c) Data can be stored in different ways.

(i) Describe how data is stored on optical media.

(2)

A description to include **two** from:
A laser heats/burns (areas of a disk) (1), which creates lands/pits (1) representing binary / 1s and 0s (1)

(ii) State the type of secondary storage that stores data as electric charges.

(1)

Solid state / flash
Accept 'SSD' for solid state

(d) An embedded computer system is part of a larger machine.

State **two** characteristics of embedded systems that make them different from general purpose computers.

(2)

Any **two** from: 1 .... • Limited processing resources • Low power consumption • Simple/robust operating system • Low cost per unit 2 .... • Smaller in size • Less storage • Limited user interface	Do not accept: 'Carries out a specific task': This is the opposite of 'general purpose', which is given in the question.

(e) Identify **two** reasons for using data compression.

(2)

☒ **A** Reduces data transfer times

☒ **B** Reduces disk fragmentation

☒ **C** Reduces required storage space

☒ **D** Reduces the chance of data being hacked

☒ **E** Reduces the need for error detection and correction

A Reduces data transfer times
C Reduces required storage space

B is not correct because parts of a compressed file can still be written to several different places on a disk
D is not correct as compression does not make data more secure encryption does
E is not correct because error detection/correction mechanism are still needed in network packets

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(f) Robust software must be free from vulnerabilities before it is released to users. Programming bugs are one type of vulnerability.

State **two other** types of vulnerability.

(2)

1 .....

2 .....

Any **two** from:

- Programming language specific vulnerabilities (directly manipulating memory)
- Security (vulnerability)
- Weak design
- Insufficient testing
- Bad programming practices (not following standards, using unvalidated 3rd party libraries)
- Inadequate validation (that fails to prevent incorrect/inappropriate data input)
- Inadequate authentication (that enables hackers to gain unauthorised access)
- Sensitive data not encrypted

(g) Some users are given administrator privileges.

Explain **one** way an operating system allows an administrator to manage users.

(2)

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A linked explanation such as:

- Users can be added/deleted (1) so multiple people can use the same computer (1)
- Edit user permissions (1) so only specific users can securely access their storage space (1)
- Control the amount of resources/storage each user can access (1) so the limited storage on the machine can be shared (1)
- Enforce user permissions (1) so only certain users are allowed to install programs / access certain files (1)

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(Total for Question 2 = 18 marks)

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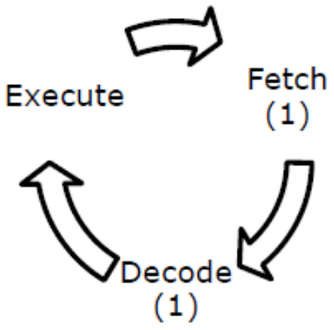
2 Computers

(a) The CPU carries out a process.

(i) Complete the diagram.

(2)



(ii) Identify the hardware component that carries instructions from memory to the CPU.

(1)

- ☒ **A** Binary shift
- ☒ **B** Control unit
- ☒ **C** Data bus
- ☒ **D** Register

C Data bus

A is not correct because binary shift is not a hardware component.
B is not correct because the control unit does not carry instructions from memory to the CPU
D is not correct because registers do not carry instructions from memory to the CPU

(iii) State the component of the CPU that carries out additions and comparisons.

(1)

Number	
2(a)iii	Arithmetic logic unit / ALU

(iv) State the reason why a higher clock speed is desirable.

(1)

Number	
2(a)iv	More instructions can be carried out each second

(v) State the name of a bus that is unidirectional.

(1)

Number	
2(a)v	Address (bus)

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(b) Describe how data is stored on magnetic media.

(2)

Any **two** from:
There is a magnetic/chemical coating on surface of the media (1)
The magnetic state/polarity of the chemical can be changed (1) to represent a 0 or 1 (1)

(c) State the type of secondary storage that uses a laser to read the disk.

(1)

Optical

(d) Some program code requires translation.

Define the term 'translation'.

(1)

Converting (human readable) code to binary/machine code

(e) Describe **two** ways a compiler differs from an interpreter.

(4)

1 2

Two linked descriptions from: • A compiler carries out translation once prior to execution (1) whereas an interpreter carries out translation every time the program executes (1) • A compiler produces a stand-alone executable file (1) whereas an interpreter is required each time the code is run (1) • A compiler reports errors after translation is complete (1) whereas an interpreter reports errors as they occur (1)	Both items in the question must be addressed in each response

(f) Describe **two** ways an operating system manages processes.

(4)

1 .....
2 .....

Two linked descriptions from:

- Uses paging / allocates addresses/sections [of RAM] (1) to share memory between processes (1)
- Extends main memory (1) by using part of secondary storage (1) (as virtual memory)
- The memory of inactive processes (1) is stored in virtual memory and swapped back when the process becomes active (1)
- Uses scheduling algorithm (1) to share processing time between competing processes (1)

(g) Describe how an embedded system that uses a sensor could control car windscreen wipers.

(2)

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A description to include **two** from:
If set pressure levels / moisture levels are reached (1) a switch could be turned on/off / windscreen wipers could be turned on/off/ / (wiper) motor speed altered (1).

(Total for Question 2 = 20 marks)

5 Computers

(a) A slow magnetic hard disk may be affected by file fragmentation.

Describe fragmentation and the process of defragmentation.

(3)

A description to include (to a maximum of 3, with at least one in each category): Fragmentation: • Files are written to disk in blocks (1). • Blocks can be dispersed (1) across the disk. Defragmentation: • Defragmentation is when file blocks are rearranged (1) on the disk. • All the blocks for one file are moved closer together (1). • All the free space is moved to be together (1).	• Defragmentation does not 'make' more free space on the disk. It only rearranges what is already there.

(b) A team of developers is using an audit trail when working on a program.

State **two** advantages of keeping an audit trail.

(2)

1 .....

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2 .....

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One mark for each to a maximum of 2:

- There's a record of who changed what when (1)
- Identifies the point at which an error/security issue was introduced (1)
- Enables the program to be rolled back to a previous state (1)
- Improve accountability/produces robust code (1)

(c) One function of an operating system is user management.

Describe **one** purpose of user management.

(2)

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A description to include:

- To provide access (1) to the device by controlling who can log on (1) to the device
- To allow a user to log on (1) by checking the username/password (1)
- By authenticating (1) the user before allowing them to log on (1)

(d) The Internet of Things has allowed devices with embedded systems to function independently and to collect and exchange data without the need for humans.

One such device is a battery-powered mower for the garden.

(i) Give **one** way each category could be used by the mower.

(4)

One mark for each to a maximum of 4, with at least one in each category

Connectivity

Connectivity:

- The mower could connect to a wireless/wired (1) network.
- The mower could have a GPS device (1).

Input

- A phone/desktop/software application (1) could be used to schedule when it will work.
- A map of the garden would be stored (1) on the mower.
- The mower would have sensors (1) to know if it ran into things/if it was dark/if it were raining/if it ran outside the garden.

Process

- The microcontroller (1) in the mower would run a program (1).
- A map of the garden would be read (1) by the program so the mower would know where to go.
- The program would monitor (1) the power status to know if it needed recharging.

Output

- The program on the mower could upload (1) statistics/information back to the application.
- The mower could have a digital readout/flashing lights (1) to indicate status.

(ii) Explain the best choice of secondary storage for the battery-operated mower.

(2)

An explanation to include:

The mower should use solid-state secondary storage (1) because it has no moving parts/can use very little power from the battery/is robust to bumps and knocks (1)

(e) Here is a representation of the contents of main memory.

Memory

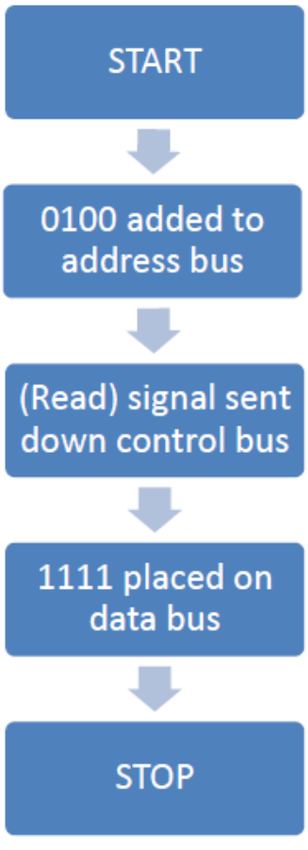
Memory location	Value
0000	1100
0011	1000
0100	1111
0101	0111

Draw a flowchart to show the process required to read the contents of memory location 0100 into the CPU.

You must include in your response:

- the buses used
- the contents of each bus.

(6)



2 marks for each box between START and STOP.

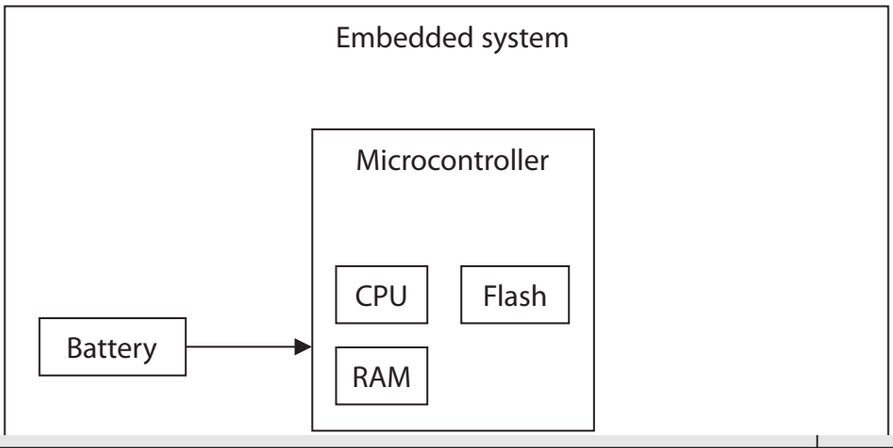
Award 4 marks max if the order is incorrect.

narks)

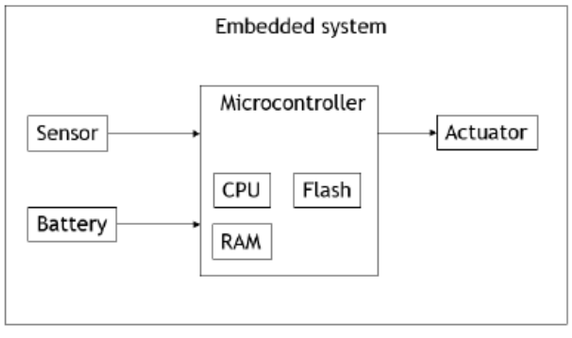
TOTAL FOR PAPER = 75 MARKS

3 Computers

(a) Complete the diagram of an embedded system by adding labelled boxes and arrows to show **one** sensor and **one** actuator that controls a motor.



- Sensor with an arrow indicating input only (1)
- Actuator with an arrow indicating output only (1)



- Position of sensor/actuator doesn't matter, as long as it's outside the microcontroller box.

(b) Explain the way a code review works.

(2)

Code reviews are carried out by programmers/specialist software (1) so that they can identify security bugs/security issues/bad practice (1)

(c) Identify which **one** of these is a hardware component of the CPU.

(1)

- ☒ **A** Clock
- ☒ **B** Control bus
- ☒ **C** Data bus
- ☒ **D** Register

D Register
- A Clock - sits outside the CPU and sends a signal to the CPU
- B Control bus - carries signals into and out of the CPU
- C Data bus - carries data into and out of the CPU

(d) Here is an image of secondary storage. Three files (A, B, and C) are stored on it. Each file is made up of several blocks (1, 2, 3, 4, etc.).

		C1	C2	A2		A3		A1	C3	B1		B2	A4		

(i) Assume the secondary storage is a magnetic hard disk.

Complete the image to show the state after running a defragmentation utility.

(2)

• All file blocks of each file are in sequence/one after another (1) • All blank space is together (1)	• Order of files does not matter. • Award second bullet if space is at front or end.

(ii) Give **one** reason the performance of a solid-state drive is **not** affected by fragmentation.

(1)

Any one from:
- A solid-state device has no moving parts (1)
- Seek time is not affected by scattered data because it is read electronically (1)

(e) When using a compiler to translate source code to machine code, the translation only needs to be done once.

Give **three other** features of a compiler.

(3)

1 … • Translates the entire source file to machine code in one go/translates all the source code prior to execution (1) … • Shows all syntax errors at the end of the translation process (1) • Produces a single executable/object code/platform-dependent output (1) 2 … • Separates the tasks of translation and execution (1)	• No marks for a response that restates the question, such as inputs source code and outputs machine code.

1 .....

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2 .....

3 .....

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(f) The operating system manages peripherals.

Identify an additional piece of software that is required for the operating system to manage peripherals.

(1)

- ☒ **A** Analogue to digital converter
- ☒ **B** Assembler
- ☒ **C** Device driver
- ☒ **D** Disk defragmenter

C Device driver • A Analogue to digital converter - used to conver representations of audio sound • B Assembler - used to translate low-level mnem • D Disk defragmenter - used to rearrange file blo storage to improve its performance

(g) Describe **two** ways that a high-level language differs from a low-level language.

(4)

1 .....

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.....

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2 .....

Any **two** from: • High-level languages use instructions that look like English (1), whereas a low-level language uses mnemonics/binary code (1). • A high-level language statement generates many lines of machine code (1), whereas each line of low-level languages is/generates a single machine instruction (1) • High-level languages are general purpose/exist across microprocessors/CPUs/machine-independent (1), whereas a low-level language is microprocessor/CPU/machine specific (1) • High-level languages are abstracted from the hardware (1), whereas low-level languages manipulate the hardware directly (1)	• Responses should be about the languages, not about the output of the language translators (efficiency) or other software based on the language (tools)

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(Total for Question 3 = 16 marks)