9 A washing machine uses sensors and a microprocessor to control the washing cycle of clothes.

(a) A sensor is used in each of the given tasks.

Identify **one** suitable sensor that would be used for each task.

Each sensor given must be different.

Task	Sensor
checking the water is 30 °C	
checking the water acidity level after detergent is added	
checking the weight of the clothes to make sure that the machine is **not** overloaded	

[3]

(b) Describe how the sensor and the microprocessor are used to make sure the water remains at 30 °C.

.....

9(a) One mark per each correct sensor. **3**

Task	Sensor
checking the water is 30 °C	**Temperature**
checking the water acidity level after detergent is added	**pH**
checking the weight of the clothes to make sure that the machine is **not** overloaded	**Pressure**

9(b) **Six** from: **6**

- Sensor sends data to microprocessor
- Data is converted from analogue to digital (using ADC)
- Data is compared to stored value (of 30)

If data is below 30 then a **microprocessor sends signal** is sent to a heater to heat the water up/add hot water

- if data is above 30 then a **microprocessor sends signal** is sent to turn the heater off to allow the water to cool down/add cold water
- Actuator used to turn headset on/off // Actuator used to add water
- If data is 30 then no action is taken
- It is a continuous process

2 An automated water tap system uses a sensor and a microprocessor to operate. Water flows from the tap when a person's hands are placed underneath the tap. Water stops flowing when the person's hands are removed from underneath the tap.

(a) Explain how the water tap system uses a sensor and a microprocessor to operate.

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.....

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..... [6]

2(a) **Six** from:

- Motion/proximity/infra-red sensor is used
- Sensor sends data to microprocessor
- Data is converted from analogue to digital (using ADC)
- Data is compared to **stored/set** value(s)
- If data is **inside range/outside range/greater than/less than**, **signal** is sent to turn water tap on
- If data is **outside range /inside range/less than/greater than**, tap remains off / **signal** is sent to turn water tap off
- Actuator is used to turn the tap off/on
- Whole process is continuous

(b) **Three** descriptions are shown of different systems.

Identify the most suitable sensor that could be used in each system.

Description of system	Sensor
it checks the air is dry enough in a garage that spray paints cars	
it automatically switches on the headlights on a car when it is dark	
it checks that the soil in a greenhouse has the correct level of acidity	

[3]

2(b) **One** mark for each correct sensor

Description of system	Sensor
it checks the air is dry enough in a garage that spray paints cars	Moisture/humidity
it automatically switches on the headlights on a car when it is dark	Light
it checks that the soil in a greenhouse has the correct level of acidity	pH

(c) The mobile phone has a USB port to allow a USB connection to a computer.

(i) Describe how data is transmitted using a USB connection.

.....

.....

.....

..... [2]

(ii) One benefit of a USB connection is that the cable can only be inserted into the port one way, so an incorrect connection cannot be made.

Give **three** other benefits of using a USB connection to connect a mobile phone to a computer.

Benefit 1 .....

.....

Benefit 2 .....

.....

Benefit 3 .....

.....

[3]

4(c)(i)	Any **two** from: • Using serial transmission • Data is sent one bit **at a time** • Data is sent down a single wire
4(c)(ii)	Any **three** from: • It can charge/power the device • It is a universal/industry standard • Fast rate of data transfer • Supports different data transmission speeds • **Automatically** detects the phone • Backward compatible • Little chance of data being skewed

(d) When a user is reading a text on the mobile phone, they may also get a telephone call on the mobile phone. An interrupt signal is generated that results in an output to inform the user that a person is calling them.

Describe how the interrupt signal is processed to inform the user that a person is calling them.

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.....

..... **[4]**

4(d)	Any **four** from: • The interrupt signal is **sent to the CPU/processor** • The CPU stops the task it is currently processing … • … to service the interrupt • An interrupt service routine is used (to service the interrupt) • Once the interrupt is serviced, a message is displayed to notify the user of the call

6 A museum has Quick Response (QR) codes that allow visitors to view videos for extra information about items in the museum.

The visitor is given a portable device with a display screen, that they can use to read each QR code.

(a) Describe how the QR code is read and processed to display the video for the visitor.

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.....

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.....

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.....

..... [4]

- The device shines a light/laser onto the QR code
- Corners of code are used to determine position/orientation
- Black and white sections of code reflect light differently
- The device captures the light that is reflected back …
- … using sensors
- The light reflections are converted to binary
- Link/URL to **video** is stored in the QR code

(b) Tick (✓) to show whether the videos are MP3 files, MP4 files or MIDI files.

	Tick (✓)
MP3 files	☐
MP4 files	☐
MIDI files	☐

[1]

(c) The video files are compressed using lossy compression.

Give **two** benefits of using lossy compression to compress the video files.

Benefit 1 .....

.....

Benefit 2 .....

.....

[2]

6(b)	• MP4
6(c)	Any **two** from: • Reduces the size of the **file** • Takes up less storage space • Quicker to transmit to device • Use less bandwidth • Less buffering

(d) The portable device has a Light-Emitting Diode (LED) display screen to allow the visitor to watch a video.

Describe how the LED screen operates to display the video.

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..... **[4]**

6(d)	**Four** from: • **Display** made up of pixels • … that are arranged in a matrix • LEDs are behind the screen • Light shone at pixels • Can have diffuser is used to distribute light evenly • RGB filters used • … and are mixed to create different colours

7 The paragraph explains how an instruction is processed by the Central Processing Unit (CPU).

Complete the paragraph using the list of terms. **Not** all terms in the list need to be used.

- address bus
- Arithmetic Logic Unit (ALU)
- calculations
- data bus
- decoded
- execute
- fetched
- interrupt
- Memory Address Register (MAR)
- Memory Data Register (MDR)
- Program Counter (PC)
- protocol
- ROM
- stored

An instruction is ..... from RAM into the CPU, where it is temporarily stored in the ..... . The instruction is then sent along the ..... to the Control Unit (CU) to be ..... . The ..... will then perform any ..... and logic operations that are required to ..... the instruction.

[7]

- Fetched
- MDR
- Data bus
- Decoded
- ALU
- Calculations
- Execute

5 A farm has an automated drinking system for its animals. The drinking system has a water bowl that contains the water. When the water bowl is empty, it is automatically refilled.

The system uses a sensor and a microprocessor.

(a) Identify the most appropriate sensor for this system.

..... [1]

(b) Describe how the sensor and the microprocessor are used to automatically refill the water bowl.

5(a)	Any **one** from: • Level • Pressure • Moisture
5(b)	Any **Six** from: • Sensor **continually** sends **digitised** data to microprocessor • Microprocessor compares data to stored value(s) • If value is outside range / matches microprocessor sends **signal** to release water to refill water bowl • … bowl filled by set amount // bowl filled for certain time • Actuator used to release water • Whole process repeats **until turned off/stopped**

8 A computer is connected to a network and assigned an IPv4 address.

(a) Tick (✓) **one** box to show which device would assign the IPv4 address to the computer.

A Domain name server (DNS) ☐

B Network interface card (NIC) ☐

C Router ☐

D Web server ☐

[1]

(b) Describe the characteristics of an IPv4 address.

.....

.....

.....

.....

.....

.....

.....

..... [4]

8(a)	• C
8(b)	**Four** marks from: Any **FOUR** from: • It is denary based • … with numbers between 0 and 255 • It is 32 bits • 4 sets/groups of numbers • … **separated** by dots Any **TWO** from: • It is a **unique** address • It can be **static** or **dynamic** • It can be **public** or **private** • It contains the network prefix • … and the host number

2 A library has a self-checkout system that allows customers to register books that they want to borrow.

The self-checkout system has a central processing unit (CPU).

The CPU has two cores.

(a) State the purpose of a core in the CPU.

.....

..... [1]

(b) The CPU is replaced with one that has four cores.

Explain the effect this has on the performance of the self-checkout system.

.....

.....

.....

..... [2]

2(a)	Any **one** from: • To perform a fetch-decode-execute cycle • To **process** / **execute** an instruction
2(b)	**Two** from: • It may increase the performance • … because more instructions can be processed **simultaneously**

(c) The CPU contains registers and buses.

(i) Describe the role of a register in the CPU.

.....

.....

.....

..... [2]

(ii) Identify **one** bus that can be found in the CPU and explain its purpose in the fetch–decode–execute cycle.

Bus .....

Purpose .....

.....

.....

.....

[3]

2(c)(i)

Two from:

- To store / holds **data / address / instruction**
- … temporarily

2(c)(ii)

One mark for correct name of bus. **Two** marks for matching description.

Address bus
Transmit / carries addresses …
… between **components** in the CPU

Data bus Transmit / carries data …
… between **components** in the CPU

Control bus
Transmits control signals …
… from the **control unit** to other **components** in the CPU

3 **Five** network terms or definitions are given in the table.

Complete the table by giving the missing term or definition.

Term	Definition
router	....
.....	This address is assigned by the network and used to identify a device on a network.
network interface card (NIC)	....
.....	This address is assigned by the manufacturer and is used to uniquely identify the device.
.....	This can be hardware or software based and filters traffic coming into and out of a network.

[5]

Term	Definition
router	a device that forwards packets to their correct destinations in a network
IP address	this address is assigned by the network and used to identify a device on a network
network interface card (NIC)	this is a component in a device that enables it to connect to a network
MAC address	this address is assigned by the manufacturer and is used to uniquely identify the device
firewall // proxy-server	this can be hardware or software based and filters traffic coming into and out of a network

5 Complete and annotate the diagram to demonstrate how packet switching is used to transmit data across a network, including the use of routers, from Device A to Device B.

[4]

The diagram demonstrates (**one** mark for each):

- Packets sent through several routers
- … taking different routes from device A to device B
- Packets arrive out of order
- Packets being reordered when all arrived at device B

9 A device can be given an internet protocol (IP) address. This can be an IPv4 or IPv6.

(a) Give **one** similarity between IPv4 and IPv6.

.....

..... [1]

(b) Describe **two** differences between IPv4 and IPv6.

1 .....

.....

.....

.....

2 .....

.....

.....

.....

[4]

9(a)	Any **one** from: • They can both be used to identify a device (on a network) • They can both be static / dynamic • They are both unique (to a device on a network) • They can both be assigned by a router • They can both be public/private
9(b)	**Four** from: • IPv4 is usually written as denary • … IPv6 usually written as hexadecimal • IPv4 is separated using dots • … Pv6 is separated using colons • IPv4 is 32-bit • … IPv6 is 128-bit • IPv4 is 4 groups of digits • … IPv6 is 8 groups of digits • IPv4 digits are between 0 and 255 • … IPv6 digits are between 0000 and FFFF • IPv4 all 0s are displayed • … IPv6 can use double colons to replace repeated groups of 0000 • IPv4 has fewer available unique addresses • ... IPv6 has more available unique addresses

(c) A web page is requested using an IP address.

(i) Identify the system that stores a database of uniform resource locators (URLs) and their corresponding IP addresses.

..... [1]

(ii) Identify the software that sends a request to the IP address to obtain the web page data.

..... [1]

9(c)(i)	• Domain name server // DNS
9(c)(ii)	• Web browser

10 A computer has pages A, B and C that are stored in RAM. Page D needs to be sent to the RAM but the RAM is full.

Page B is **not** needed immediately.

Explain how virtual memory can be used in this scenario.

.....

.....

.....

.....

.....

.....

.....

..... [4]

10 Any **four** from:

- The secondary storage / hard drive can be partitioned to create the virtual memory
- … and page B sent to the virtual memory …
- … which makes space for page D in RAM
- … Once page A / C / D / another page is not required / has been processed
- … page B can be sent from the virtual memory back to RAM when it is required

3 The table contains **four** descriptions about a computer system.

Complete the table by writing the correct term for each description.

Term	Description
.....	A collective term for the physical components of the computer system.
.....	A type of software that provides services that the user requires and allows the user to perform tasks on the computer.
.....	A type of software that manages the main functions of the computer, including managing files and managing memory.
.....	A type of software that is stored in the read only memory (ROM). It includes the basic input output system (BIOS) and the bootloader.

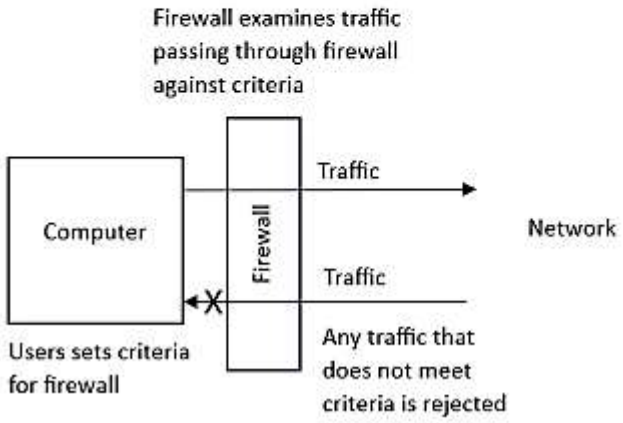
[4]

Term	Description
hardware	A collective term for the physical components of the computer system.
application software	A type of software that provides services that the user requires and allows the user to perform tasks on the computer.
operating system	A type of software that manages the main functions of the computer, including managing files and managing memory.
firmware	A type of software that is stored in the read only memory (ROM). It includes the basic input output system (BIOS) and the bootloader.

6 Draw and annotate a diagram to demonstrate how a firewall works.

The diagram includes (any **four** from):
- Traffic passing both ways through the firewall
- An indication that criteria is set for the firewall
- Traffic is compared to criteria
- Traffic being rejected if it does/does not meet criteria
- Traffic being accepted if it does/does not meet criteria

e.g.



3 A user's computer has a central processing unit (CPU) that has a clock speed of 2 GHz.

She wants to change it to a CPU that has a clock speed of 3 GHz.

(a) (i) State what is meant by clock speed.

.....

..... [1]

(ii) Explain the effect this change will have on the performance of the CPU.

.....

.....

.....

..... [2]

3(a)(i)	–	The maximum number of FDE cycles/instructions a CPU can perform/process/execute in a second
3(a)(ii)	–	Increases/improves the performance // Tasks can be performed quicker/faster
	–	… because more FDE cycles/instructions can be processed in a second

"FDE" typically stands for "Fault Detection and Exclusion". In the context of GPU (Graphics Processing Unit), this term might refer to techniques or mechanisms used to detect faults within the GPU and exclude the faulty components or processes to ensure continued operation and reliability.

(b) The CPU contains a memory address register (MAR).

Describe the role of the MAR in the fetch–decode–execute cycle.

.....

.....

.....

..... [2]

(c) The CPU has a list of all the machine code commands it can process.

State the name of this list of commands.

..... [1]

3(b)	– **Stores** addresses … – … of next instruction/data to be fetched // where data is to be written to
3(c)	– Instruction set

4 A washing machine is an example of an embedded system.

(a) Give **two** characteristics of an embedded system.

1 .....

.....

2 .....

.....

[2]

4(a)	Any **two** from: – Performs a single/limited/dedicated function/task – It has a microprocessor – It has **dedicated** hardware – Uses firmware – It is normally built into a larger device/system – User normally cannot reprogram – It does not require much power – It is cheap **to manufacture** – Works automatically // works without human intervention – It is small (in size) – It is a real-time system

(b) Circle **three** other examples of an embedded system.

freezer laptop

personal computer (PC) security light system smartphone

vending machine web server

[3]

4(b) **One** mark for each correct system:
- security light system
- freezer
- vending machine

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3 A computer has a central processing unit (CPU).

(a) Circle **three** components that are built into the CPU.

accumulator (ACC) control unit (CU) graphics card

hard disk drive (HDD) motherboard program counter (PC)

random access memory (RAM) read only memory (ROM)

[3]

(b) The CPU has cache.

Explain the purpose of the cache.

.....

.....

.....

..... [2]

3(a)	– Accumulator (ACC) – Control unit (CU) – Program counter (PC)
3(b)	Any **two** from: – It is a type of storage – …that stores **frequently used** data/instructions – To speed up **access** – … as it is faster to access than RAM – It has different levels e.g. L1 – L3

(c) The CPU has a component that regulates the number of fetch–decode–execute cycles the CPU can perform in a second.

State the name of this component.

..... [1]

(d) The CPU has a component that carries out all calculations and logical operations.

State the name of this component.

..... [1]

3(c)	– Clock
3(d)	– Arithmetic logic unit // ALU

8 Draw and annotate a diagram to represent the role of a router.

The diagram demonstrates (**one** mark for each part):

- The router examining the packet …
- … looks for the packet header
- … looking for the IP address of destination

- The packet being sent toward its correct destination
- … by the fastest route // decides which route it takes

- Router is shown connecting devices/networks
- Router is shown assigning an IP address to a device

e.g.