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GCSE Computer Science Paper 1

1.1 Systems Architecture

1 Purpose of the CPU

- Executes instructions to run programs
- At the heart of the computer
- Works with ALU, CU and registers

2 Main CPU Components

- **ALU** carries out calculations and logical operations
- **Control Unit (CU)** controls the fetch-decode-execute cycle and sends control signals
- **Cache** small, fast memory storing frequently used data and instructions

3 Registers

MAR	stores the address of data/instructions to be accessed
MDR	stores data being transferred to or from memory
PC Program Counter	stores address of the next instruction
Accumulator	stores results of calculations and temporary data

Address = location in memory | Data = value or instruction

4 Fetch-Execute Cycle

1. PC → Program Counter sends next address to MAR
2. Instruction is fetched from memory into MDR
3. PC +1 Program Counter increments
4. Control Unit decodes instruction
5. ALU CPU / ALU executes instruction
6. Cycle repeats continuously

5 Von Neumann Architecture

- Data and instructions are stored in the same memory
- Used by most modern CPUs

6 CPU Performance

Clock speed	more clock cycles per second means faster processing
Cache size	larger cache reduces need to access RAM
Number of cores	more cores allow more tasks at once, though not all software uses them fully

Embedded Systems

- Computer systems built into larger devices
- Designed for one specific task
- Little or no user interface
- Efficient, reliable, often low power
- Examples: washing machine, microwave, traffic lights

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OCR GCSE Computer Science – 1.2 Memory & Storage

Paper 1 Mindmap

1 Primary Storage

- Needed for data/instructions currently used by CPU
- Fast access
- **RAM:** volatile, stores running programs/data
- **ROM:** non-volatile, stores firmware/boot instructions
- **Virtual memory:** uses secondary storage when RAM is full; slower than RAM

2 Secondary Storage

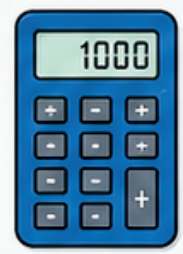
- Non-volatile, long-term storage
- Needed to store files when power is off
- Types:
  - **Solid-state:** SSDs/flash, no moving parts, fast, portable
  - **Optical:** CDs/DVDs/Blu-ray, laser read, cheap per disk, low capacity
  - **Magnetic:** HDDs, moving parts, cheap, high capacity, used for backups

- **Quick comparison:**

HDD	SSD	Optical
high capacity, cheap per GB, less portable	fast, durable, expensive per GB	low capacity, cheap disks, good for media distribution

3 Units & File Size Formulas

- bit = 1 binary digit
- nibble = 4 bits
- byte = 8 bits
- KB = 1,000 bytes
- MB = 1,000 KB
- GB = 1,000 MB
- TB = 1,000 GB
- PB = 1,000 TB



- Sound size = sample rate × duration × bit depth
- Image size = colour depth × width × height
- Text size = bits per character × number of characters

4 Binary, Decimal & Hex

10 2 16

- Decimal = base 10
- Binary = base 2
- Hex = base 16 (0–9, A–F)
- Binary uses place values in powers of 2
- MSB = highest-value bit
- LSB = lowest-value bit
- Convert binary to decimal by adding place values
- Convert decimal to binary using place values/subtraction
- Binary addition: remember carries; overflow if result is too large
- 1 hex digit = 4 bits = 1 nibble
- Binary ↔ hex by grouping into nibbles

5 Binary Shifts

Left shift = move bits left, add 0 on right

1 0 1 1 → 0 1 0 1 0

Multiplies by 2 each shift

Right shift = move bits right, add 0 on left

1 0 1 1 → 0 1 0 1 1

Divides by 2 each shift

- Used in bitmasking, graphics, compression, encryption

6 Characters / Text

A 0100 0001

- Character encoding turns characters into binary
- Character set = characters + binary codes
- ASCII uses 8 bits per character
- Unicode uses 8 to 32 bits, supports more languages/symbols/emojis
- More bits = more unique characters
- Text file size = bits per character × number of characters

7 Images

- Images are made of pixels
- Each pixel stores a colour value in binary
- Colour depth = bits per pixel
- Higher colour depth = more colours
- Resolution = width × height in pixels
- Metadata may include format, resolution, colour depth, device
- Image size = colour depth × width × height
- Higher resolution/colour depth = better quality but larger file size

8 Sound & Compression

A Sound

- Sound is analogue; computers store digital samples
- Sample rate = samples per second (Hz)
- Bit depth = bits per sample
- Higher sample rate/bit depth = better quality, bigger file size
- Sound size = sample rate × duration × bit depth

B Compression

- Compression reduces file size
- Used to save storage and speed up transfer
- Lossy: some data lost, smaller files, used for images/audio/video
- Lossless: no data lost, reversible, smaller reduction
- Why compress? save space, reduce bandwidth, faster downloads/streaming

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1.3 Computer networks, connections and protocols

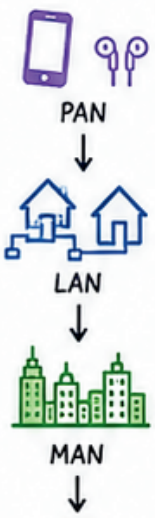
What is a computer network?

Two or more computers and devices connected together to:

- Share resources (e.g. printers, files)
- Share an internet connection
- Communicate (e.g. email, messages)
- Allow central management and security

Types of network

- **PAN** (Personal Area Network)
  Very small network around one person (e.g. Bluetooth between phone and headphones).
- **LAN** (Local Area Network)
  Covers a small area such as a home, school or office.
- **MAN** (Metropolitan Area Network)
  Covers a larger area such as a town or city.
- **WAN** (Wide Area Network)
  Covers a large geographical area such as countries or the whole world.



Network devices

Devices that allow networks to work.

- **Router** – connects different networks together and routes data between them.

- **Switch** – connects devices in a LAN and sends data to the correct device.

- **Hub** – connects devices in a LAN but sends data to all devices (less efficient than a switch).

- **Access Point** – allows devices to connect wirelessly to a wired network.

- **Modem** – connects a network to the internet (modulates/demodulates data).

Network topologies

The way devices are arranged and connected.

- **Star** – All devices connect to a central hub or switch.

- **Bus** – All devices connect to a single backbone cable.

- **Ring** – Each device connects to two others, forming a ring.

- **Mesh** – Devices are connected to many or all other devices.

The Internet

The Internet is a global network of networks. It uses the TCP/IP protocol suite to communicate.

IP address

Each device on a network has a unique IP address so data can be sent to the correct device.

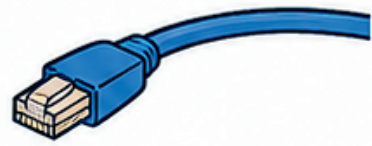
Two versions:

- **IPv4** – e.g. 192.168.1.10
- **IPv6** – longer address, e.g. 2001:0db8:85a3:0000:0000:8a2e:0370:7334

Connection methods

Wired connections

Use physical cables.



- More reliable
- Faster speeds
- More secure
- Less affected by interference
- Example cables: Ethernet (twisted pair), fibre optic

Wireless connections

Use radio waves.

- More convenient (mobile devices)
- Easier and cheaper to set up
- More affected by interference
- Less secure than wired
- Examples: Wi-Fi, Bluetooth

Protocols

Rules and conventions that control communication between devices. They ensure data is sent, received and understood correctly.

Examples of protocols:

- **TCP/IP** – controls how data is split into packets, sent, routed and reassembled.
- **HTTP/HTTPS** – used for web pages. (HTTPS is more secure)
- **FTP** – used for transferring files.
- **SMTP** – used for sending emails.
- **POP3/IMAP** – used for receiving emails.
- **DNS** – converts domain names (e.g. google.com) into IP addresses.

Benefits of using networks

- **Resource sharing** – share printers, files and software.

- **Communication** – email, instant messaging, video calls.

- **Centralised storage and backup** – easier to manage and secure.

- **Access to the Internet** – share one connection between many devices.

- **Cost effective** – sharing resources saves money.

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1.4 Network security

Protecting data, devices and networks from unauthorised access, damage or theft.

What is network security?

Network security is the protection of data, devices and networks from:

- Unauthorised access
- Attacks and threats
- Damage or disruption
- Loss or theft of data

Common threats

- **Malware** – software designed to harm or gain access to systems (e.g. viruses, worms, Trojans, ransomware).
- **Hacking** – gaining unauthorised access to systems or data.
- **Phishing** – tricking users into revealing sensitive information (e.g. passwords) by pretending to be trustworthy.
- **Social engineering** – convincing people to break security procedures or give away information.

Preventing unauthorised access

- **Strong passwords**
  - Use long, complex passwords with a mix of letters, numbers and symbols.
  - Change passwords regularly.
- **Two-factor authentication (2FA)**
  - Requires two forms of ID to log in (e.g. password + code sent to phone).
- **Access control**
  - Limits who can access systems and what they can do.
  - Examples: user accounts, permissions and user groups.

Firewalls

A firewall monitors and controls incoming and outgoing network traffic based on security rules.

It acts as a barrier between a trusted internal network and untrusted networks (e.g. the internet).

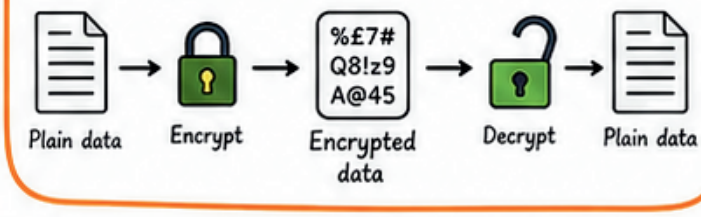
Types:

- **Hardware firewall** – a physical device between the network and the internet.
- **Software firewall** – a program on a computer or device.

Encryption

Encryption scrambles data so that only authorised users can read it.

- Protects data when it is stored or being transmitted over a network.
- Uses an algorithm and a key to encrypt and decrypt data.



Anti-malware software

Software that detects, prevents and removes malware.

Types of anti-malware:

- **Antivirus** – detects and removes viruses.
- **Anti-spyware** – detects and removes spyware.
- **Anti-ransomware** – protects against ransomware attacks.

Securing a wireless network

- Change the default router name (SSID).
- Use strong encryption (WPA3/WPA2) and a strong password.
- Turn off WPS (Wi-Fi Protected Setup).
- Keep router firmware up to date.

Good security practice

- Keep systems and software up to date (updates fix security vulnerabilities).
- Backup data regularly.
- Be careful what you click – don't open links or attachments from unknown senders.
- Log out of accounts and lock devices when not in use.
- Use security settings on devices and apps.

Why is network security important?

- Protects data from loss, theft or damage.
- Keeps systems and networks running smoothly.
- Protects personal information and privacy.
- Helps organisations avoid financial loss and damage to reputation.
- Helps organisations comply with laws and regulations (e.g. GDPR).

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1.5 Systems software

Software that manages computer hardware and provides a platform for other applications.

What is systems software?

Systems software manages and controls the computer's hardware and provides a platform for application software to run.

It includes:

- Operating systems
- Utility programs
- Device drivers
- Language translators

The operating system (OS)

Controls the computer's resources and provides common services for programs.

Responsibilities:

- Manages CPU (scheduling tasks)
- Manages memory
- Manages files and storage
- Manages input and output devices
- Provides a user interface
- Runs and manages applications
- Handles security and access control

Examples: Windows, macOS, Linux, Android, iOS

Utility programs

Perform maintenance tasks to keep the computer running smoothly.

Common utilities:

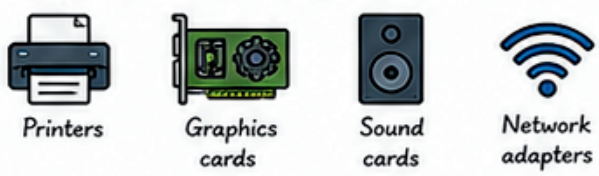
- **Anti-virus** – protects against malware.
- **Disk cleanup** – removes unnecessary files.
- **Defragmenter** – reorganises files on storage to improve speed.
- **Backup programs** – copy data to protect against loss.
- **Compression tools** – reduce file sizes (e.g. ZIP files).

Device drivers

Allow the operating system and programs to communicate with hardware devices.

- Translate instructions between the OS and the device.
- Usually written by the device manufacturer.
- Need to be installed for new devices.

Examples of devices that need drivers:



Language translators

Convert code written in high-level or assembly language into machine code (binary) that the CPU can execute.

Assembler	Converts assembly language into machine code. e.g. NASM, MASM
Compiler	Converts high-level language (code) into machine code. e.g. GCC, Visual C++
Interpreter	Translates and executes code line by line. e.g. Python interpreter

All translators check for errors in the code.

Operating system interfaces

The OS provides interfaces for users and programs to interact with the system.

Interface	Description
Command Line Interface (CLI)	Text-based interface where users type commands. e.g. Windows Command Prompt, Linux Terminal
Graphical User Interface (GUI)	Uses windows, icons, menus and mouse pointer. e.g. Windows desktop, macOS Finder
Touch / Gesture Interface	Users interact using touch, taps, swipes and gestures. e.g. Smartphones, tablets

OS can support more than one interface.

Booting the computer

When a computer is switched on, the OS is loaded into memory and started.

Boot process:

1. BIOS/UEFI performs POST (Power-On Self Test) to check hardware.
2. Bootloader is loaded from storage.
3. Bootloader loads the operating system into RAM.
4. OS starts and the user interface is displayed.

Boot device order can be set in BIOS/UEFI (e.g. SSD, USB, CD/DVD).

Why systems software is important

- Manages hardware resources efficiently.
- Provides a platform for application software to run.
- Allows users to interact with the computer.
- Improves security and protects data.
- Keeps the system running smoothly and reliably.

Key differences: Systems software vs Application software

Feature	Systems software	Application software
Purpose	Manages hardware and provides a platform.	Performs specific tasks for the user.
Examples	Operating systems, utilities, drivers, translators.	Word processors, games, web browsers.
When it runs	Runs in the background; often starts when computer starts.	Runs when the user opens it.
User interaction	User interacts indirectly (via interfaces).	User interacts directly.
Essential?	Essential for the computer to work.	Not essential (depends on user needs).

Summary

Systems software is the bridge between hardware and applications.

It ensures the computer works efficiently, securely and reliably while allowing users and programs to use the hardware easily.

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1.6 Ethical, legal, cultural and environmental impacts of digital technology

Ethical issues

Ethics are moral principles that influence how technology is used.

- **Privacy** – how organisations collect, store and use personal data.
- **Accuracy** – ensuring information is accurate and reliable.
- **Property** – respecting ownership of digital content.
- **Access** – ensuring technology is available to everyone.
- **Use** – using technology responsibly and not causing harm.

Ethical considerations

When using digital technology, individuals and organisations should:

- Be honest and trustworthy online.
- Respect other people's privacy and intellectual property.
- Consider the consequences of their actions.
- Avoid plagiarism and only use content they have permission to use.
- Report unacceptable behaviour (e.g. cyberbullying).

Legal issues

Laws exist to protect individuals and organisations.

- **Data Protection Act 2018 / UK GDPR** – controls how personal data is collected, stored and used.
- **Computer Misuse Act 1990** – prevents unauthorised access to computer systems, and hacking.
- **Copyright, Designs and Patents Act 1988** – protects original works, software and media.
- **Obscene Publications Act 1959** – makes it illegal to publish obscene material.
- **Regulation of Investigatory Powers Act 2000** – controls how organisations can monitor communications.

Cultural impacts

Digital technology affects how we live, communicate and share information.

Positive impacts

- Connects people from different cultures.
- Shares ideas, traditions and knowledge.
- Promotes creativity and collaboration.
- Provides access to education and information.

Negative impacts

- Loss of local cultures and traditions.
- Spread of inappropriate or offensive content.
- Digital divide – not everyone has equal access to technology.
- Dependence on technology can reduce face-to-face interaction.

Environmental impacts

The production, use and disposal of digital technology can affect the environment.

Negative impacts

- **Energy use** – data centres and devices use large amounts of electricity.
- **Resource depletion** – mining for rare materials to make devices.
- **E-waste** – electronic devices contain harmful substances and can pollute land and water if not disposed of properly.
- **Carbon footprint** – manufacturing, transport and use of devices produce greenhouse gases.

Positive impacts

- Technology can help reduce paper use and save resources.
- Smart technology can improve energy efficiency.
- Easier communication can reduce travel.

Social impacts

Digital technology influences how people communicate and behave.

Positive impacts

- Instant communication with friends and family.
- Easy access to online services (banking, shopping, entertainment).
- Supports remote working and learning.
- Helps people stay connected and share ideas.

Negative impacts

- Cyberbullying and online harassment.
- Addiction to devices and social media.
- Health problems (e.g. eye strain, poor posture, lack of sleep).
- Spread of misinformation and fake news.

Economic impacts

Digital technology affects businesses, jobs and the economy.

Positive impacts

- Increases productivity and efficiency.
- Creates new jobs and industries (e.g. app development, tech support).
- Enables global trade and online shopping.
- Reduces costs for businesses (e.g. online advertising vs. print).

Negative impacts

- Automation can lead to job losses for some workers.
- High initial costs for new technology.
- Smaller businesses may struggle to compete with larger companies online.

Minimising negative impacts

Individuals, organisations and governments can take action to reduce harm.

- Use technology responsibly and consider others.
- Keep personal data private and secure.
- Recycle or donate old devices.
- Use energy-efficient devices and services.
- Follow laws and respect copyright.
- Report online abuse and illegal content.
- Promote digital literacy and responsible use.

Summary

Digital technology has many positive impacts, but it can also cause negative effects. It is important to use technology responsibly, follow laws and consider the ethical, cultural, social, economic and environmental consequences.

Ethical	Legal	Cultural	Social	Economic	Environmental
Do what is right. Respect privacy, property, accuracy, access and use.	Obey the law. Protect data, prevent crime and respect copyright.	Share and respect cultures, but be aware of loss of traditions and digital divide.	Improves communication and services, but can cause harm and affect wellbeing.	Creates opportunities and growth, but can also cause job losses and costs.	Uses resources and energy, but can be managed to reduce harm to the planet.