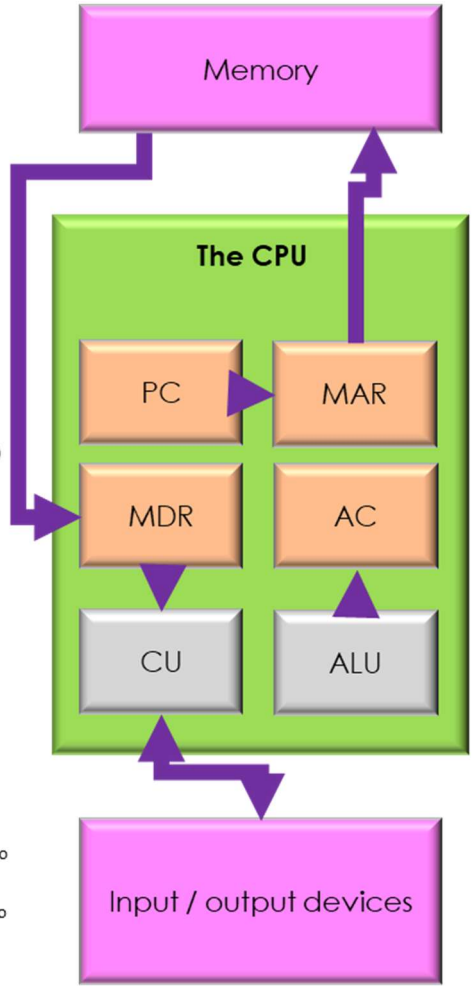
Computing Mastery Booklet – *Use this to help you revise key concepts and master previous learning*

Topic 1 - CPU

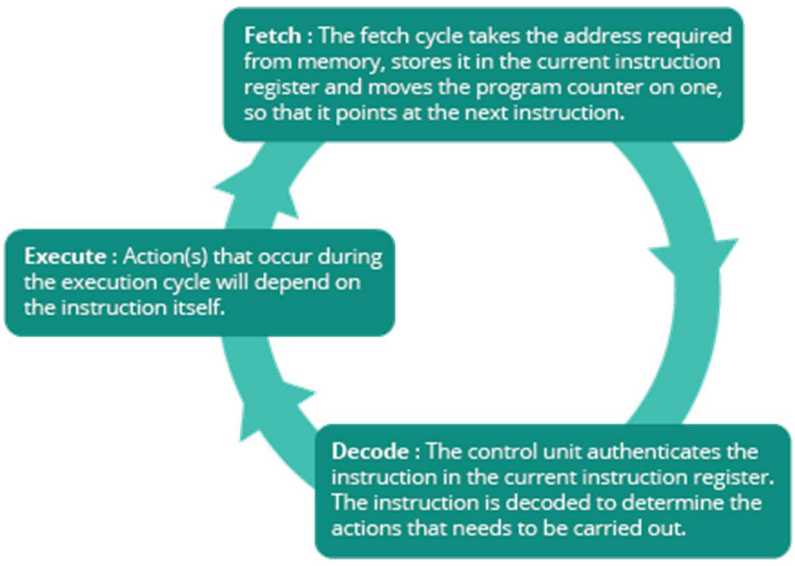


1. Memory
2. Input/output devices
3. PC (Program counter)
4. MAR (Memory address register)
5. MDR (Memory data register)
6. AC (Accumulator)
7. ALU (Arithmetic/logic unit)
8. CU (Control unit)
9. Arrow from PC to MAR
10. Arrow from MAR to memory
11. Arrow from Memory to MDR
12. Arrow from MDR to CU
13. Arrow from ALU to AC
14. Arrows from CU to Input/output devices

Key terminology

Term	Definition
Central processing unit (CPU)	The main component in a computer for processing data and instructions.
Control unit (CU)	Directs the flow of instructions and/or data and coordinates the other parts of the CPU. It generates clock ticks.
Arithmetic logic unit (ALU)	The ALU performs all the mathematical calculations / logical operations in the CPU.
Cache	Incredibly fast, but very expensive volatile memory used by the CPU.
Registers	Fast access storage locations found on the CPU where data or control information is temporarily stored.
Program counter (PC)	A counter that keeps track of the memory address of the instruction to be executed next.
Current instruction register (CIR)	A temporary holding area for the instruction that has just been fetched from memory.
Accumulator (ACC)	A register for temporary storage of arithmetic and logic data in the CPU.
Memory address register (MAR)	Stores the address in the main memory that is currently being read or written.
Memory data register (MDR)	Stores the data in the main memory that is currently being read or written.
Memory	Used for the temporary storage of currently running programs and data.
Clock speed	The number of FDE cycles that a CPU can carry out per second.
Cores	Some processors have multiple processors (cores) which can work in parallel, sequentially or can multitask.

The Fetch-Decode-Execute (FDE) cycle

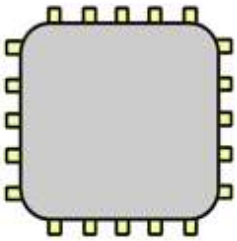


The CPU is the main processing component in a computer system, it is often called the brain of the computer. The CPU has several sub-components:

ALU (Arithmetic Logic Unit)– is the part of the CPU that processes and _____ data. It performs simple calculations on the data that is temporarily stored in the registers. Examples of calculations that an ALU might perform are _____ and subtraction.

Controller - sends and receives _____ from all parts of the computer. This ensures that all processes take place at the right time and in the correct order. These signals _____ along a **control bus**.

Fill in this CPU



Registers – these are storage locations found on the ____ where data or control information is temporarily stored. Registers are usually much _____ to access than internal memory, since they have to be accessed so often.

Internal memory (*sometimes called level 1 cache memory*) is fast access _____ storage on the CPU. Data is moved from the registers to the internal memory when it is not being actively used. Data from internal memory can then either be written to RAM or called back into the registers for further processing. This process of using internal memory _____ up the processing of data.

CPU	manipulates	travel	signals	speeds	addition	faster	temporary

Performance is affected by greater

- cache size
- clock speed
- number of cores.

Cache size

- Can store more data and instructions.
- It can provide instructions and data to the CPU at a much faster rate (than other system memory such as RAM).

Clock speed

- The FDE cycle will run faster, resulting in more instructions being processed.

Number of cores

- More instructions can be processed at the same time.

NOTE: Performance may be affected where one core is waiting on the result of another and therefore cannot carry out any more instructions.

PC	The program counter (PC) contains the allocation of the instruction which has to be fetched
MAR	Using the address bus, the contents of PC is copied to MAR
MDR	The instruction at that particular location is copied to MDR temporarily
CIR	The contents of the MDR is copied to the current instruction register (CIR)
+1	The value in the PC is then incremented by 1 so that next instruction can be fetched
Execution	The instruction is decoded and then executed by sending out control signals to the memory and input-output devices

Cover the diagram at the side and describe what happens in the Fetch – Decode – Execute cycle your own words in the space below

What can improve CPU performance? [3 marks]

_____

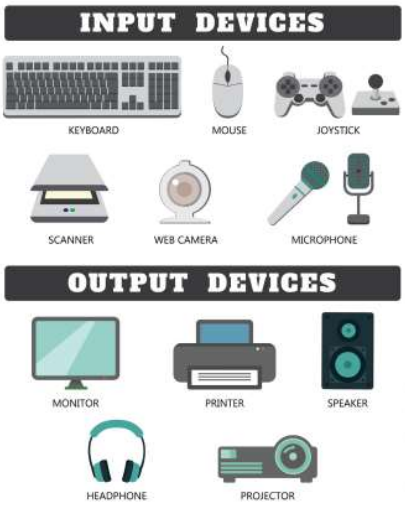
_____

_____

Key terms

Term	Definition
Input	Data is sent to the computer system using a device.
Output	Data is received from the computer system using a device.
Virtual memory	Data that appears to be stored in main memory, but some of is actually held in secondary storage. Data is transferred between the two automatically as required.
Volatile	Stored data is lost when the power is interrupted or switched off.
Permanent	Stored data is kept when the power is interrupted or switched off.

Input and output devices



Primary storage

Summary of the different types of memory:

Type	Cache memory	Read-only Memory (ROM)	Random Access Memory (RAM)	Flash memory	Virtual Memory
Volatile or permanent	Volatile	Permanent	Volatile	Permanent	Volatile
Data can be changed	✓		✓	✓	✓
Relative speed	★★★★★	★★★★	★★★	★★	★
Example use	The temporary storage of frequently accessed data and instructions.	Storing programs such as the system BIOS.	Storing currently running programs and data.	Storing the programs such as the system BIOS.	Compensates for a main memory shortage by temporarily storing data in secondary storage.

Additional hardware components

Graphics Processing Unit (GPU)

Integrated GPU

- Uses the computer's RAM
  Cheaper than installing a dedicated GPU
- Generates less heat and uses less power
- Perfect for general graphics processing such as watching or editing videos and word processing.

Dedicated GPU

- Has its own video memory
- Provides the best visual experience
- Used by people such as professional graphic designers and serious gamers
- Uses more power and require a good cooling system.

Sound cards

- The sound card will convert analogue input signals into digital data and reverse this process for output.

Motherboards

- The motherboard is the main circuit board of the computer.

Secondary storage

	Functional characteristics	Devices		Capacity	Durability	Portability	Speed	Cost
Solid state	• A non-mechanical design of semiconductor chips • It does not require defragmentation • There are two types of solid state memory NOR and NAND		Flash memory drive	2 GB – 512 GB	★★★★	✓	★★★★	~~££££~~
Solid state	• Both contain cells (transistors) in a grid, but the wiring between the cells differs • If a chain of transistors conducts current, it has the value of 1. If it doesn't conduct current, it's 0.		Solid-state drive	128 GB – 4 TB	★★★★		★★★★	~~£££££~~
Magnetic	• Each sector can be magnetised as 1 or demagnetised as 0 • Data is read and written using a mechanical arm that has a head at the end • In hard disc drives, a platter is divided into billions of tiny areas. As the disk spins, the arm travels across the disk • Each sector of the platter can store data and the movement of both the disk and the read / write head means that every sector on the hard drive can be reached.		Hard disc drive	250 GB – 16 TB	★		★★★	~~£££~~
Magnetic			Magnetic tape drive		★★	✓	★	£
Optical	• A pit is "burned" with a laser beam into the surface • A pit represents 0 • The lack of a pit (a flat, unburned area on the disc, called a land) represents the number 1 • Data is stored in a continuous spiral.		CD / DVD / Blu-ray Drive	CD: 700 MB DVD: 9 GB BD: 50 GB	★★★	✓	★★	~~££~~
Cloud storage	• A technology that allows users to store their data on third-party servers. They can then access that data from many computing devices.			Unlimited		✓		Free / subscription based

Embedded systems

An embedded system is a combination of software and hardware that performs a specific task whereas a general-purpose computer is designed to carry out multiple tasks.

Examples include - MP3 players, mobile phones, video game consoles, digital cameras, DVD players, and GPS. Household appliances, such as microwave ovens, washing machines and dishwashers.

Cover the answer and above and attempt your own answer - What is an embedded system? [1 mark]

_____

Match up the key terms:

1. Adware	A) Created to provide remote access to a computer without detection. This can allow it to modify system settings and even install other types of malware.
2. Bot	B) Used to track users activity without their knowledge and might use key loggers to monitor actions taken by the user and gain personal information.
3. Ransomware	C) Encrypts the user personal data using strong encryption methods and will demand a ransom to decrypt. This ransom will usually be in the form of a fee.
4. Rootkit	D) These enter users computer as a normal file or program and once downloaded, will perform malicious tasks to steal confidential information.
5. Spyware	E) A type of malware that can copy itself and spread to other users by attaching itself to other files.
6. Trojan	F) This is designed to provide users with advertisements in the form of pop-ups that redirect them elsewhere.
7. Virus	G) A type of malware that needs user actions to spread it and as a result, can continue to spread, exploiting the network and consuming bandwidth.
8. Worm	H) An automated type of malware used to perform DDOS attacks to get access to servers.

What is malware?

How can it be prevented?

What attacks are not mentioned in the list?

What is social enginerering?

Match them up

These characteristics are used to decide what type of storage is best suited to a given purpose. Match up the characteristics to correct statement.

1. Capacity	A. This refers to how quickly the data can be read and transferred from the storage device.
2. Cost	B. This refers to how easy is it to transport from one place to another.
3. Speed	C. This refers to how expensive per byte it is.
4. Portability	D. This refers to longevity – how well does it maintain performance over time?
5. Durability	E. This refers to how resistant it is to external factors such as being dropped, scratched and how it responds to being in extreme conditions.
6. Reliability	F. This refers to how much space is available on the storage device.

RAM vs ROM – what is the difference? [4 marks]

3 types of storage technologies

- List and describe them

1.	
2.	
3.	

Amir has a home network that includes two laptop computers, four mobile phones, and two televisions.

Amir wants to protect the computers on his network from threats such as unauthorised access.

The following incomplete table contains a form of attack, description and method of preventing each attack.

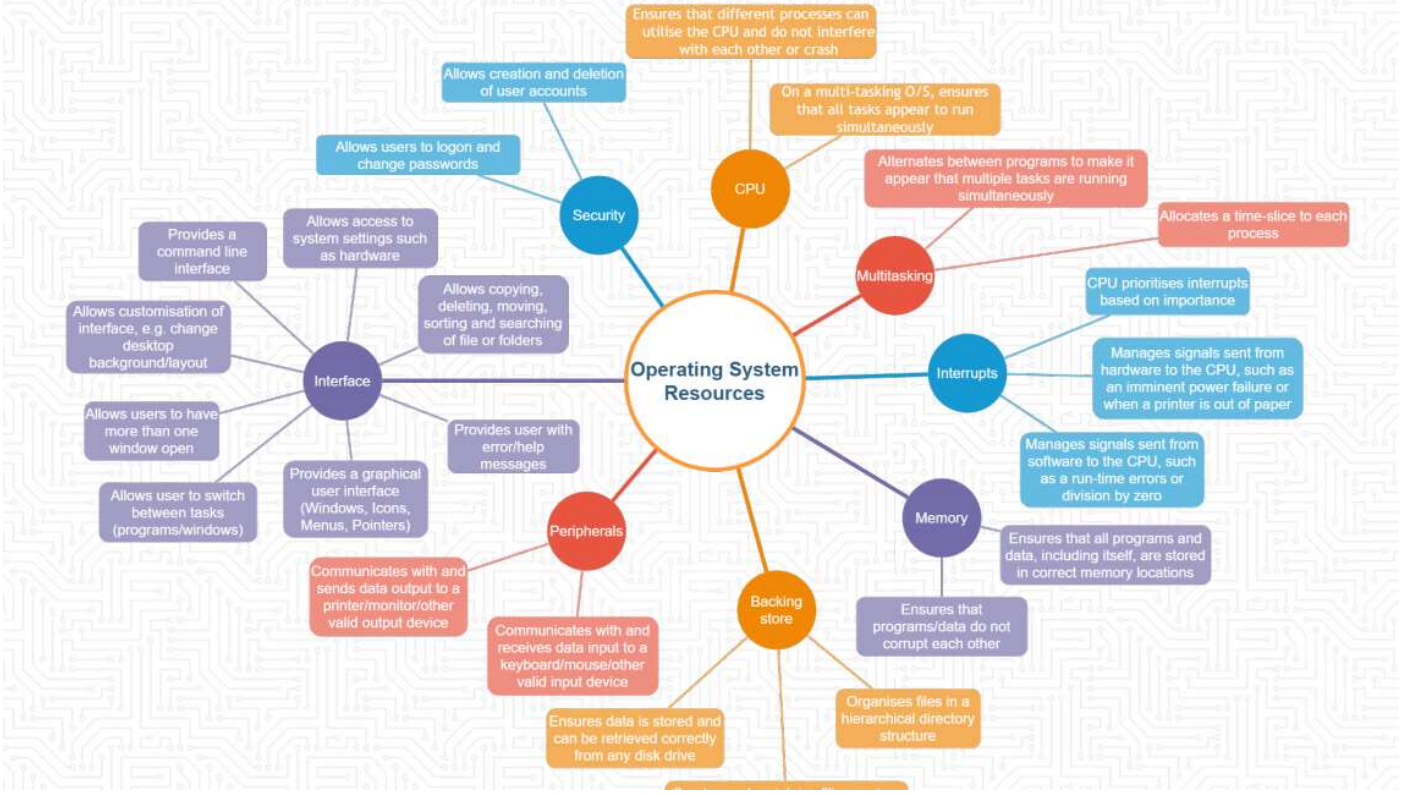
Complete the table by writing the missing Forms of attack, Descriptions and Methods of prevention.

Form of attack	Description of attack	Method of prevention
	A program attempting all possible password combinations	
Data interception		
		Anti-virus

What is the difference between cache memory and virtual memory?

The purpose of the operating system

An operating system is software that manages a computer system. The operating system is loaded by the bootstrap loader. One of its primary functions is to manage resources.



Using A,B,C,D, E,F, name different types of utilities software

A=

B=

C=

D=

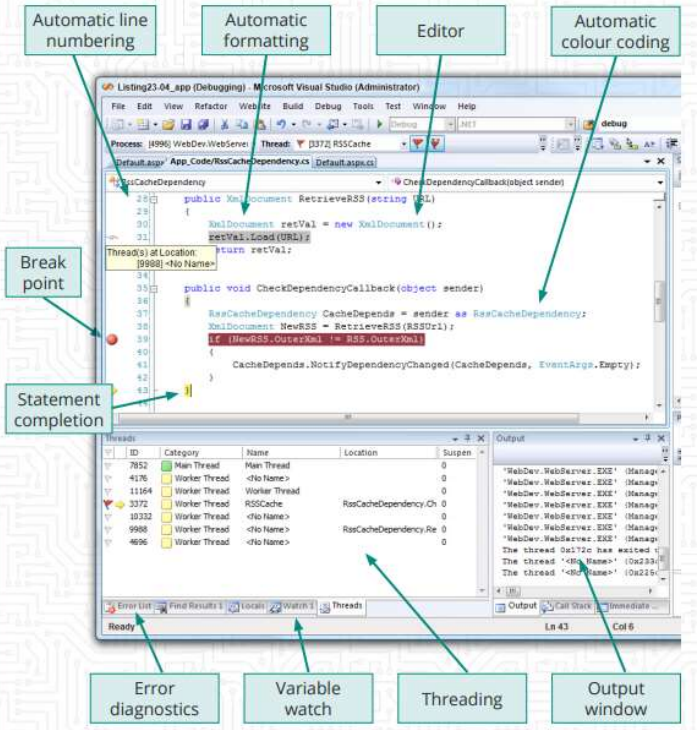
E=

F=

Key terms

Term	Definition
Editor	Allows a programmer to enter, format and edit code.
Automatic formatting	Correctly indents code.
Automatic colour coding	Changes key words, literals and annotation to different colours.
Compiler	Translates source code into executable machine code. Once compiled, a program can be run at any time.
Interpreter	Translates each line/a single line of source code and executes it
Linker	A program which allows previously compiled code, from software libraries, to be linked together.
Loader	A program which loads previously compiled code into memory.
Debugger	A program which helps locate, identify and rectify errors in a program.
Trace	A facility which displays the order in which the lines of a program are executed, and possibly the values of variables as the program is being run.
Break point	Interrupts a program on a specific line of code.
Variable watch	Displays the current value of any variable.
Memory inspector	A facility which will display the contents of a section of memory.
Error diagnostics	Used when a program fails to compile or to run. Error messages are displayed to help the programmer debug.
Syntax error detection	Highlights syntax errors before code is translated.
Routines / subroutines	A sequence of program instructions that performs a specific task.
Library	A collection of commonly used private functions and subprograms, such as square root / saving data to disk.
Statement completion	Auto-completes a statement such as adding an 'end if' to an 'if' statement

Example of an integrated development environment (IDE)



Advantages of using libraries

- Related private functions and subprograms are stored in the same location
- Time is saved as the programmer can simply use the private functions and programs stored in a library

What is an IDE?

_____

_____

_____

Cover the key words and explain the following terms in your own words:

Editor	
Compiler	
Interpreter	
Linker	
Breakpoint	
Trace	
Variable watch	

What is the difference between a compiler / interpreter – giving both advantages/disadvantages

_____

_____

_____

_____

_____

_____

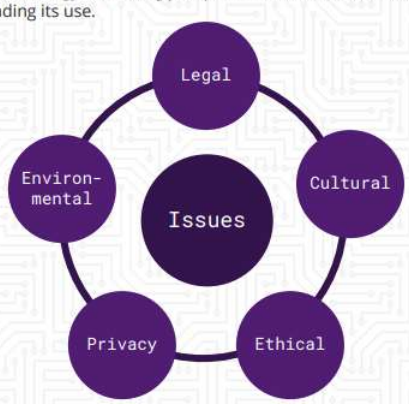
What are the different types of errors – explain them

Key terms

Term	Definition
Legal	Rules which a particular country or community recognises as regulating the actions of its members and which it may enforce by the imposition of penalties.
Cultural	The ideas, customs, and social behaviour of a society.
Ethical	Relating to beliefs about right and wrong and conforming to standards of conduct.
Privacy	An individual's anonymity and how safe they feel in a location.
Environment	The surroundings or conditions in which a person, animal, or plant lives or operates.
Code of ethics / conduct	Defines acceptable behaviour within an organisation.

Impacts

Digital technology increasingly requires us to consider issues surrounding its use.



Legal issues

The following legislation has been put in place to govern the use of computer systems.

Legislation	Overview
The Computer Misuse Act (CMA) 1990	Helps combat issues arising from the misuse of computer systems. The Act makes it an offence to: • access data without permission, e.g. looking at someone else's files • access computer systems without permission, e.g. hacking • alter data stored on a computer system without permission, e.g. writing a virus that deliberately deletes data.
The Freedom of Information (FOI) Act 2000	People have a right to know about the activities of public authorities, unless there is a good reason for them not to have this information. The Act provides public access to information held by public authorities, who are obliged to publish certain information about their activities.
The Regulation of Investigatory Powers Act (RIPA) 2000	Regulates the powers of public bodies to carry out surveillance and investigation. It also regulates the interception of communications. The Act provides clear legal guidelines for organisations, such as the security services and the police, to carry out surveillance and access the digital communications of individuals, such as email, telephone calls, text messages etc.
The General Data Protection Regulation (GDPR) and Data Protection Act (DPA) 2018	The GDPR and DPA applies to all 'personal data'. Personal data is classed as any information relating to a person who can be directly or indirectly identified and so it needs to be protected.
Copyright Designs and Patents Act 1988	This Act gives the authors of any digital software the right to control the ways in which their work may be used.
Creative Commons (CC) Licensing	This license enables the free distribution of copyrighted work. A CC license is used when an author wants to give other people the right to share, use, and build upon a work that they have created.
Telecommunications Regulations Act 2000	This Act gives organisations the right to monitor communications on their own networks. Previously such interception would have been unlawful unless consent had been given by both the sender and the recipient.

Impacts (continued)

Cultural issues

- The digital divide:
  - The gap between populations that have full access to modern ICT, and those who have restricted access.
  - The divide traditionally exists between those in cities and those in rural areas; between the educated and the uneducated; between socioeconomic groups; and globally, between the more and less industrially developed nations.
- The changing nature of employment:
  - Teleworking – employees working from home
  - Collaborative cloud-based documents enable workers to share documents with their employer
  - Communication can be via email or video conferencing
  - Many technology-based jobs have been moved abroad, where costs are cheaper
  - Automation of processes using technology has led to a fall in manual, low-skilled work, such as warehouse packing
  - More high-skilled work is now available, which includes the maintenance of automated systems.

Ethical issues

- Self-driving cars - making decisions between life or death for its driver and other people
- Artificial intelligence - could the creation of thinking machines raise a host of ethical issues including the potential to harm humans.

Privacy issues

- The use of drones for surveillance
- Tracking people internet usage and information shared with websites visited
- With whom the data and information is shared
- The storage of personal data, including biometric data on a server.

Environmental issues

- Increase in delivery lorries on the road has caused increased congestion and increases in carbon emissions
- Are we a paperless society? More and more paper seem to be consumed affecting rainforests and influencing global warming
- Old computer equipment needs to be disposed of correctly which is expensive. Dumping old computers on landfill sites can cause pollution of toxic substances into the water supply and lead to health problems
- Computer equipment generates heat so many organisations install air conditioning systems leading to increased carbon emissions
- Many computers are left on standby, wasting electricity unnecessarily and increasing carbon emissions
- Mining the rare earth elements required in the manufacture of computers causes pollution
- Global assembly lines and pollution from transportation.

Professional standards

Code of conduct

It is important for employees to conform to professional standards, including formal and informal codes of ethical behaviour.

Each code of conduct is different and usually reflects an organisation's ethos, values and business style. Some codes are short and set out general guidelines, whereas other codes are large documents that include a variety of aspects relating to an organisation's values, ethics, objectives and responsibilities.

Formal codes of ethics are usually enforced by the threat of disciplinary action should the code not be adhered to.

An individual's own personal code

An individual's own personal code often supersedes the bare minimum requirements of an organisation's code. An individual's own personal code will vary from person to person as they choose to act upon their own ethical standards in their everyday actions.

IT systems and the internet in the workplace has caused a lot of issues over their acceptable use. The inappropriate use of these systems has many negative impacts on businesses and so many businesses implement acceptable use policies. Discuss the pros and cons of implementing such an acceptable use policy.

_____

_____

_____

Businesses have many other ethical responsibilities to their customers and employees. Some of these are listed in the table below. Identify an impact of each of these ethical responsibilities on individuals

Copyright	
Computer Misuse	
Protection of Data	
Privacy	
Accessibility	

Key terms

Term	Definition
High Level Language	A programming language designed to simplify computer programming. It is "high-level" because it is several steps removed from the actual code run on a CPU
Low Level Language	A programming language that contains basic instructions recognised by a CPU. Two common types of low-level languages are assembly language and machine code.
Assembly Language	A low-level programming language designed for a specific type of processor that can be converted to machine code using an assembler.
Mnemonic	A short code used in assembly language; chosen to remind the programmer of the program instruction it represents.
Machine Code	A low-level language comprised of binary digits.
Program Translation	Translating code, using either an interpreter or compiler into executable machine code
Embedded Software	Software built into embedded systems written to control machines or devices that are not typically thought of as computers

Characteristics of Low Level Languages

High-level languages are designed to be closer to humans than to computers.

The programs:

- Require translation into machine code.
- Are portable. The translated programs can be run on different computers running different operating systems without modification.
- Are written in code similar to English, or other recognisable language. This helps when reading writing and maintaining the programs.
- Allow access to module libraries.
- Use data types and data structures, selection statements and repetition/iteration constructs.
- Use logic operators and functions that are built into the language.

Examples of High Level Languages

Most contemporary programs are written using high-level languages, including GCSE and A level projects.

Examples include Java, C#, Python and many others.

Uses of High Level Languages

Used when execution speed is not the most critical factor, including, for writing:

- Office applications and database packages
- Operating systems
- e-commerce software and social media apps.

Characteristics of Low Level Languages

The programs:

- May be finely tuned so that the code is more efficient.
- May have more system-dependent features available.
- Are usually not portable.
- Are usually harder to program:
  - because the programmer has to pay more attention to fine details,
  - and because it takes more lines of code to achieve the same result.

Examples of Low Level Languages

Assembly language

Code written using mnemonics that can make use of machine-dependent instructions.

Advantages include:

- The translated program requires less memory
- Code can be executed faster

Machine Code: The opposite of a high-level language made up entirely of bit patterns that can be executed directly by the CPU. All programs must be translated into machine code before they can run on a computer.

Uses of Low Level Languages

Used when execution speed and efficient memory use are critical. Examples include: Operating systems, device drivers and embedded software.

Professional game developers often use console specific development software, which is likely to include low-level features for performance.

What is the difference between low level and high level language?

_____

_____

_____

What is opcode? _____

What is operand? _____