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Bit	A binary digit. Can be a 1 or a 0. The smallest unit of storage. All data in a computer system is represented by patterns of bit
2 to the power of the number of bits	The formula to work out how many unique patterns can be made with a given number of bits.
Binary	Base 2 number system. 1 bit = 1 or 0. The more bits the more data can be represented. $2^{\text{number of bits}}$ is the formula to work out how many unique patterns can be made. Used because computers can only understand 2 states.
Denary	Base 10. Our 'normal' number system
Hexadecimal	Base 16. 0-9, 10=A, 11=B, 12=C, 13=D, 14=E, 15=F Used because it is easier for humans than working with long binary numbers. Reduces the risk of human errors. Used in colour codes and in IP addresses.
Converting to/from hex	Start with 8-bit binary. Split into 2 nibbles. Work out denary value of each nibble. Will be between 0 & 15. Convert to hex. Do in reverse for hex to binary.
Unsigned number	Positive number. With 8 bits it will be in the range 0-255
Signed number	1 bit represents the sign (+ or-).With 8 bits will be in the range -128 to +127
Two's Complement	A method for showing signed numbers. The MSB is the sign and has a value. 1= -128. To create, start with the positive binary number, then flip the bits and add 1.
Binary addition rules	1+1 = 0 carry 1. 1+1+1 = 1 carry 1. All others as normal.
Overflow error	When the result of an addition requires an additional bit to hold the result and the additional bit is not available. Leads to the wrong answer & unpredictability in a program.
ASCII character set	Standard list of characters recognised by a computer. **Standard ASCII is 7-bit** – represents 128 characters. Extended ASCII is 8 bits – represents 256 characters. Letters are organised in a sequence. In Python chr(96) will return the Ascii character for the number inside the brackets. ord("A") returns the Ascii number.
Pixel	The smallest unit of colour in a bitmap image.
Bitmap	A digital image made up from pixels. Pixels are the smallest element in an image.
Resolution	The number of pixels **per inch**. Usually written as PPI or DPI (dots per inch). The higher the resolution the more detail in an image
Colour depth	The number of bits available to store colour data about each pixel. 1-bit =2 colours etc. The more bits, the more colours can be represented.
Calculating image file size	Width in pixels x height in pixels x colour depth = file size in bits.
Units of storage	Bit (the smallest unit of storage. Can represent 2 unique values. $2^{\text{number of bits}}$. 4 bits = nibble. Used in hex conversions. 8 bits = 1 byte. A byte is the standard unit of storage. 1024 bytes make 1 Kibibyte. 1024 Kibibytes make 1 Mebibyte (Mib). 1024 Mebibyte make 1 Gibibyte (Gib). 1024 Gib makes 1 Tebibyte (Tib).
Unit conversions	Bits to bytes: divide by 8. Bytes to bits: multiply by 8. Bytes to kibibytes: divide by 1024. Kibibytes to mebibytes: divide by 1024. Example: Mib to bits – multiply by 1024 (Kb), then by 1024 (bytes), then by 8
RGB	A true-colour image (eg. Photo) is made up from red, green & blue. Colour depth is 24. Each pixel has 8-bits for a shade of red, 8-bits for a shade of green, 8-bits for a shade of blue.
Analogue sound	Sound represented using continuous data from the sound wave

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Digital sound	Sound represented by taken measurements of the sound wave at regular intervals. Some data is lost.
Sampling	Taking measurements of the amplitude (height of the sound wave) at regular intervals. Eg. 44100 times per second
Frequency (sampling rate)	The number of sound samples taken per second, measured in Hertz. The higher the frequency, the closer the digital sound is to the original.
Amplitude	The height of a sound wave.
Bit depth	The number of bits used to encode a sound sample. (Like colour depth for images). The larger the number of bits the more data about the sample can be stored, making it closer to the original.
Calculating sound file size	Sample rate (frequency) in seconds x bit depth x length of sound in seconds. Answer is in bits.
Compression	Removing data in order to reduce file size for storage or transmission reasons. The trade-off is between file size and file quality. How close to the original the file still is. Transmission means the sending of data.
Lossless compression	Data is encoded so no data is permanently lost but the file size is smaller. Eg. 100 blue pixels encoded as 100B.
Lossy compression	Permanent removal of data. When used for sound & image files humans generally don't notice the missing data as removed out of their hearing range or image made smaller to fill in gaps. No good for text files as would make the text unreadable.
Input-Process-Output model	All computer systems work on this model. Including general computer systems & specialised embedded systems.
Von Neumann model	The stored program model of computing systems. Both program data & program instructions are held in main memory (RAM) ready for processing by the CPU.
Central Processing Unit (CPU)	A hardware device that carries out processing in a computer. Contains a control unit, ALU, registers, cache & clock
RAM	Main memory. Random Access Memory. Volatile. Temporarily holds program data & instructions about currently open programs.
Bus	A wire, or group of connections in a computer system.
Control bus	Carries control signals from the control unit to other parts of the CPU & input/output devices. Bidirectional
Address bus	Carries the address of the memory location that the CPU will read from or write to. Unidirectional from CPU to RAM
Data bus	Carries the value being read from or written to memory. Bidirectional between CPU and RAM
Fetch-Decode-Execute cycle	The series of steps repeatedly carried out by the CPU in the Von Neumann model.
ROM	Read-only memory. Holds the start-up instructions for the computer. Non-volatile.
Volatile	Holds data only while power is on. Eg. RAM
Non-volatile	Holds data even when a device has no power. Eg. ROM, secondary storage
Cache	Superfast, expensive memory within the CPU that holds frequently used instructions & makes up for differences in speed between the CPU & RAM.
Registers	Small memory locations within the CPU. Used to hold an instruction, data or memory address used during the FDE cycle.

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Clock	An electronic device within the CPU which synchronises the actions of the CPU. 1 'tick' is 1 cycle of the FDE cycle. Measured in GHz. 1 GHz is 1 billion cycles per second.
Overclocking	The process of speeding up the clock speed to more than it was designed for. Can cause overheating.
Arithmetic Logic Unit	ALU. Performs arithmetic and logic operations within the CPU.
Virtual memory	Part of secondary storage which is used by the operating system if RAM becomes full.
Pipelining	The stages of the FDE cycle are overlapped to improve the performance of the CPU.
Secondary storage	Permanent storage of software & files. Usually a hard drive, SSD or optical device.
Magnetic storage	Works by magnetising parts of a surface so the north and south poles represent the 1s & 0s. Common in traditional hard drives but also magnetic tape.
Optical storage	Blu-ray, DVD, CD. When writing, a laser burns non-reflective parts of a disc (called pits) leaving reflective parts (called lands). Pits & lands represent 1s & 0s.
Solid State Storage	SSD, memory stick, SD cards. Electrical secondary storage. Use chips called NAND flash. Special transistors that traps electrons in pools. Full pools represent 1s and empty pools represent 0s.
Embedded systems	Designed to do a specific job, often within a larger system. Will have an input(s), process & output(s). **Embedded systems are low cost per unit, have a limited user interface and are require limited power and processing resources. They are also smaller and have less storage than a general purpose machine.**
Boolean logic	AND, OR, NOT. Used in logic gates (electronic circuits) & in programming. Eg. In IF statements. AND if both conditions are true, OR if one condition is true; NOT reverses the condition – true becomes false
Software	Programs that run on a computer. Called apps (applications) on mobile devices
Operating system(OS)	The software that is designed to manage other programs access to the hardware, including input & output devices. Eg. Windows, Android, IOS. Also provides a user interface The OS is responsible for file management, process management, peripheral management and user management.
File management	The OS displays files in a hierarchical system which makes it easier for both users **AND** the OS to easily find saved files.
Process management	The OS is responsible for allocating CPU time to open programs using scheduling algorithms.
Scheduling	The algorithm the OS uses to allow each running program to use the CPU. The OS prioritises the running programs & switches between them on each clock cycle of the CPU.
Paging	The algorithm used by the OS to switch program data & instructions between RAM & virtual memory once main memory (RAM) is full.
Peripheral management	Peripherals are pieces of hardware connected to a computer to increase its function. Eg. printer, speakers, keyboard. OS manages the use of these and communicates with the device driver of each.
Device driver	A program that relays data & instructions between a peripheral and the OS. Each peripheral has its own device driver.
Utility software	Software that does a useful job for the user. Not essential & not a reason for buying the device in the 1st place. Usually bundled with the OS. Types of utility software: **E**ncryption, **C**ompression, **D**efragmentation, **B**ackup, **A**nti-malware, **F**ile repair.
Encryption	Scrambling data within a file so it is unreadable except by the person or device that has the key to decrypt.
Compression software	Utility software that reduces file size in order to free up space or for sharing online. Eg. via email

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Defragmentation (Disc defragmenter)	Moving file blocks on a disk so they are closer to each other, in order to speed up disk access & improve performance. Defragmentation only required on mechanical, magnetic hard drives.
Backup	The process of creating copies of data **IN ANOTHER LOCATION**, possibly the cloud, so that it can be recovered in the event of data loss or damage.
Full backup	The entire contents of a device are copied to another location.
Incremental backup	Only data that has been changed since the last backup is backed up. Much faster.
Anti-malware software	Utility software that detects & provides protection against attacks from malicious software.
File repair	Utility software that extracts as much reusable data from a corrupted file as possible.
High level programming languages	Close to English. Eg. Python, Java, C+ etc.
Low level programming languages	The binary language of a computer. AKA machine code. May be referred to as an instruction set which is the list of all commands that a CPU knows. Assembly language.
Assembly language	A low level language sometimes used for software for embedded systems because it is very efficient. But very difficult to write in. Use **mnemonics** such as LDA. Each instruction in assembly language is equivalent to one machine code instruction (machine code = binary)
Mnemonic	A memory aid. Shortens information to make it easier to remember. Used in assembly language to represent instructions. Used to make the assembly language commands easier to learn/remember/write
Source code	The code of a program.
Translator	A program that converts high level source code into machine (binary) code.
Interpreter	A translator that converts from HLL to LLL line by line. Flags errors as they arise. Programs run on an interpreter run slower than a compiled program. Source code is available for editing.
Compiler	A translator that converts the whole program into a single executable file to be run. Errors are only reported at the end & the source code is not available for editing.
Robust software	Software that can cope with the unexpected without crashing, revealing sensitive data or generating incorrect outputs.
Code vulnerability	A flaw in a program that puts security at risk.
Code review	Code is examined by an senior programmer or using specialist software. Purpose is to identify any poor programming practices, find vulnerabilities and check code efficiency.
Audit trail	A record of who changed code and what changes they made. Increases accountability among a team of programmers. Helps prevent sabotage and reduces errors because people are more careful.
Network	2 or more devices connected together. In order to share data/files, internet connection, peripherals like printers/scanners, to communicate, to share software/update software.
Local Area Network(LAN)	Over a small geographical area. Uses its own hardware such as routers & cables.
Wide Area Network (WAN)	Over a large geographical area. Uses 3rd party hardware & cabling. Internet is a WAN.
Client-Server network	A network that has at least 1 server to provide services to clients. A client (node or workstation) requests data or a file from the server using the server's address. The requested data will be sent back to the client using the client's address.
Peer-to-peer network	A network with no central servers. Each device on the network acts as a client & a server.
Authentication	Validating that someone is who they say they are. Often done using a user name & password.

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Topology	The arrangement of connected devices on a network.
Star topology	Each device is connected to a central hub or switch. If a cable fails, the whole network doesn't go down. Can add new devices easily. Easier to locate faults than with a ring or bus topology. But if hub/switch fails, the whole network fails. More expensive to install & needs specialist knowledge to install & maintain.
Switch	A network device that directs data between a server & the device that requested the data. At the heart of a star network.
Server	A specialist computer that performs a specific job on a LAN or WAN. Eg a web server holds webpages, a print server deals with printing, email server with printing, logon server with logins etc
Wi-Fi Access Point (WAP)	Allows devices with a wireless network card to connect wirelessly to a wired network,
Methods of connection	Wired or wireless. Wired connections are either copper cable (carrying electricity) or fibre optic (carrying light. Faster than copper). Wireless connections are either Bluetooth or Wi-Fi. Occasionally infrared. **Wired advantages:** faster, less easy to eavesdrop/hack, less open to interference from other devices. **Disadvantages:** expensive to install & maintain. **Wireless advantages:** no cables so cheaper to install. Allows user to join easily – just need the network name (SSID) & password; can connect anywhere within range of the WAP. **Disadvantages:** slower than wired. Other devices can interfere with the signal. Walls can get in the way. Data should be encrypted to guarantee security as easier to intercept data (eavesdrop)s
Protocol	A set of rules to say how data on a network should be formatted for sending. Formatting means how the data should look, what form it should take. Each protocol has a specific function.
Email protocols: SMTP, POP3, IMAP	SMTP – simple mail transfer protocol. Used for sending emails. POP3 – Post office protocol – used for receiving emails. Emails are downloaded from the email server to a device & then deleted from the server meaning they cannot be accessed again from another device. IMAP – internet message access protocol – for receiving email. Emails are kept on the server so can be accessed again from other devices & locations.
Web browser protocols: HTTP, HTTPS, FTP	HTTP – hypertext transfer protocol covers how data should be sent between web servers & a client's web browser. HTTPS – as for HTTP but for encrypted (secure) data. FTP – file transfer protocol – used to transfer files over a network (downloading/uploading)
TCP – Transmission Control Protocol	The rules surrounding the sending of data packets. Covers packaging, addressing & checking that data has been received. Works with the Internet Protocol (IP)
IP – Internet Protocol	Splits data into packets and addresses them.
Network protocols: Ethernet & Wi-Fi	Ethernet – a protocol used on wired networks. Covers everything from type of cables & connectors to how data is sent on the network & the speed it is sent at. Wi-Fi – a protocol covering how data is sent on wireless networks.
The TCP/IP protocol stack	A set of protocols that covers the sending & receiving of data over the internet. Consists of 4 layers. **Another Truck Is Late – APPLICATION – TRANSPORT – INTERNET – LINK**
Application layer	The 1st/top layer of the protocol stack. The layer at which the user interacts with the internet. Eg. Via a browser or email program. HTTP, HTTPS, FTP, POP3, IMAP, SMTP protocols.
Transport layer	The layer that manages communication between devices over the internet. Transmission Control Protocol.
Internet layer	The layer that deals with sending data across multiple networks. The TCP/IP protocols work on these 2 layers. They are responsible for packaging and sending data. INTERNET PROTOCOL

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Link layer. Sometimes known as data layer or physical layer	The transmission & receipt of data packets at a local network level. Either wired or wirelessly. ETHERNET & WIFI PROTOCOLS.
Data packet	A small amount of data. Has a header containing the sender & recipient's IP address as well as a sequential packet number. A body containing the data & a footer containing an error check.
IP address	A unique address that is given to a device when it connects to the internet. IP addresses change each time a device connects. It identifies the device on the internet. See difference with MAC address
IP v4 address	Consists of 4 sets of decimal numbers (from 0-255) separated by a dot. Eg. 127.92.245.123
IP v6 address	Consists of 8 sets of 16-bit hex numbers separated by a dot. Many more addresses available than IPv4.
MAC address	The permanent address of a device. Fixed at manufacture. Identifies a device on a LAN
URL – Uniform Resource Locator	AKA web address in English. Eg. http://bbc.co.uk. URLs are used as easier for humans to remember. Need to be translated into the correct IP address. Done by the DNS.
DNS – Domain Name Server	A DNS holds the IP addresses of web servers. The DNS receives the URL and sends back the IP so the router can request the webpage.
Network transmission speed	Speed is measured in bits per second. Usually megabits per second. 1 Kbps (kilobits) is 1000 bits per second. 1 Mbps (megabits) is 1000 x 1000 bits per second. NB: there is a difference between kilobits and kilobytes. There is a difference between units of storage & transmission speeds. Speeds always measured in bits per second.
Time to transmit a file	Time to transmit (in seconds) = file size (in bits) / speed (bits per second). All data needs to be converted into bits first.
Bandwidth	A measure of the capacity of a network. The maximum amount of data, in bits per second, that can be transmitted
Latency	The time between data being transmitted & the time it is received. Measured in milliseconds. Commonly known as lag. More latency with more devices on a network.
Denial of Service (Dedicated denial of service)	An attack on a website or network designed to take the service offline.
Phishing	Usually an email pretending to be from a reputable source such as a bank designed to get a user to click on a link to take them to a fake website to input personal login details or to download an attachment that may contain malware.
Virus	Software or code designed to do damage to a computer system.
Ransomware	Software that encrypts a user's files & then demands payment to decrypt the files.
Spyware	Software that records key presses (key logger) or records computer use in some other way. Designed to steal login details for fraudulent purposes.
Malware	The term that includes all software designed to disrupt or destroy a system.
Access control	A network administrator gives different levels of access to users of a network depending on their needs & the need to keep data secure. There are 3 levels: no access at all. Read-only access: users can view data but cannot delete or change data; read-write access: the highest level. Users can view, edit & delete data.
Hacking	Unauthorised access to a computer or network.
Firewall	Software or hardware designed to stop unauthorised access.

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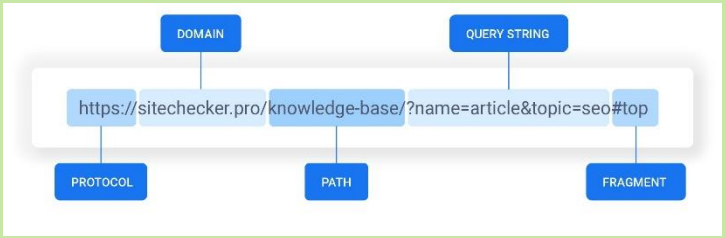
Patch/unpatched software	A patch is a security upgrade designed to 'patch' any previous vulnerability in software. Software that has not had the patch downloaded is known as unpatched software.
Eavesdropping	Intercepting data being transferred over a network, including the internet. Data is encrypted so that even if it intercepted it cannot be read.
User policy	Sets out who can do what on a network. What access rights different groups of users have.
ISP – Internet Service Provider	A company that provides internet connection to customers.
Internet	The worldwide infrastructure of networks, cables, routers & servers.
World Wide Web	The services that run on the internet. Typically web sites and email services.
Router	Networking hardware that connects networks together & routes packets towards their destination. Contain routing tables stating where to send packets for different destinations. Routers look at the IP address of the recipient in the packet's header & use the rules in the routing tables to decide which route to send the packet.
HyperText Markup Language (HTML)	The language of web pages. It sets out how the page should look. The formatting of the text – eg. Font size, colour & details of any hyperlinks.
Uniform Resource Locator (URL)	The unique web address of a web page. 
Privacy	The right to be left alone & free from unwanted scrutiny. Increased use of tech can put privacy at risk.
Personal data	Info that is unique & personal to an individual. Individuals should have the right to consent to how their data is collected, used and stored.
Identity theft	Stealing of another person's personal details in order to commit fraud.
Data Protection Act (GDPR) General Data Protection Act	The law governing the protection of personal data. Data should be kept only for the purposes stated; be kept up to date; be accurate; be relevant; be kept securely; not be kept longer than necessary; not be transferred to 'unsafe' areas of the world. People have the right to see what data is held on them & know what it is used for.
Data minimisation	Only collecting the minimum data required
Purpose limitation	Only using data for the stated purpose
Integrity and confidentiality	Keeping data secure. Password-protected; locked offices; restricted access; firewalls.
Consent	Consent must be freely given, informed, specific and be able to be withdrawn,
Big data	Huge volumes of data that is analysed & used to make decisions to hopefully benefit society.
Data breach	An issue with data security when large amounts of personal data are accessed without permission.
Surveillance technology	CCTV, drones, number plate recognition, facial recognition – tracking people & their behaviour either with or without their knowledge.
Location-based services	Using GPS & Wi-Fi to share location in services & apps. Convenient but also allows tracking.

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Intellectual Property (IP)	A unique creation of the human mind, that has value. eg. a picture, song, piece of software
Copyright, Designs & Patents Act	The law which protects the rights of a person who has created a piece of work.(IP). Copyright is automatic. Applies as soon as the work is created.
Trademarks	A symbol, word, or phrase that has been registered as representing a company & cannot be used by anyone else.
Licensing	A licence to use a piece of software. Says how many copies can be used, who can use, and where
Open source software	The licence allows users to freely use, distribute and change the software.
Proprietary software	The licence allows specific use. The source code is protected & the licence doesn't allow changes.
Artificial Intelligence	The ability of a computer or robot to perform tasks commonly performed by humans.
Algorithmic bias	Behaviours in computer programs that create unfair outcomes due to unconscious bias by the programmer
Machine learning	The ability of machines to learn on their own without being programmed. Eg. being able to identify if something belongs in the sea or not
Environmental issues	**E-waste**: poor disposal of devices; too frequent upgrades; not recycling. **Manufacture:** poor mining practices; reducing Earth's precious metals; very water intensive; high energy use; packaging; transport. **Cloud computing:** high energy use for servers & cooling.
Algorithm	A sequence of step-by-set instructions designed to solve a specific problem
Decomposition	Breaking down a large problem into smaller problems to make them easier to solve
Abstraction	Removing unnecessary details from a problem to focus on the important parts. Eg. rolling a dice – only need a number between 1 and 6. Colour, size, material of the dice is unimportant.
IDE	Integrated Development Environment – eg. Thonny, Python IDLE. An application that contains an interpreter to run a program and tools to help programmers such as auto complete, syntax checker, debugging tools.
Syntax error	An error in the programming language. Eg. missing brackets or "" Program always crashes
Logic error	An error in the algorithm. The program runs but produces an unexpected result.
Runtime error	All other errors that cause the program to crash. Occur when the program is asked to do something impossible like divide by zero or open a file that doesn't exist or is spelled differently
Version control	Keeping copies of programs as you work on them so you can go back to a previous version if mess up
Computational Thinking	The process of solving problems logically
Initialise	Set up; eg a variable or array at the start of a program
Modulo division	In Python uses the % sign. Returns the remainder of division as a whole number
Integer division	In Python uses // Returns the whole part of division and gets rid of any remainder. Used when you do not want a fraction. Eg. half a person
Variable	A named location in memory that allows the contents to change during the running of a program
CONSTANT	A named location in memory where the contents do not change during the running of a program.
Sub program	A reusable chunk of code that can be called when required. May be in-built such as print() or len() or user-defined. Eg. def menu(): Makes code shorter, more efficient.

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Function	A sub program that returns a value back to the main part of the program
Procedure	A sub program that does **NOT** return a value back to the main program
Parameter	Values that are passed into a sub program when it is called. Appear between the brackets. eg. def calcArea(pWidth, pHeight): pWidth and pHeight are the **parameters.**
Flowchart	Visual representation of an algorithm. Specific shapes connected with arrows to show data flow. **KNOW YOUR SHAPES!**
Concatenate	Join. You can concatenate/join strings to strings but not strings to integers or floats
Casting	Converting one data type to another. Eg. To allow concatenation. Eg. print("The total is " + str(total)) # where the variable total holds a float
Integer	A data type. A whole number, positive or negative
Linear search	A brute force algorithm to search for an item in an array. The algorithm starts at the 1st item and compares it to the search term. Repeats until item is found or end of list is reached. Slow & inefficient. Best case: the item is 1st in the list. Worst case: the item is last in the list or not in the list at all.
Binary search	A 'divide-and-conquer' search algorithm. THE DATA MUST BE SORTED. Find the median value. Compare to the search term. Stop if equal. If median too high, repeat with the sub list on the left. If median too low, repeat with sub-list on the right. Repeat until item found or list length is 1.
Bubble sort	A brute force algorithm to sort data in order. Start at left. Compare the values in position 1 and 2. Swap if left one is larger than right. Compare values 2 & 3. Swap if required. Repeat to the end of list (largest value now on far right). This is known as a **PASS.** Repeat until number of swaps in a pass is 0
Merge sort	A 'divide-and-conquer' sorting algorithm. Uses **RECURSION.** Divide the list into 2 parts. Keep doing this until have multiple lists of 1. Merge each pair together in order until all items are in correct order
Recursion	When a sub program calls itself with different inputs each time. Reduces the complexity of a problem
Sequence	The order of lines of code that usually affect the outcome of a program
Selection	The use of if….else in a program. Where a decision is made and a program branches
Iteration	Looping over every item in a list/array or string. Using for loops
Condition controlled loop	A repeat-until loop. Uses the keyword 'while' Repeats until a condition is met. Uses a sentry variable to hold the condition
Count controlled loop	A for loop. Repeats a set number of times. Either a fixed number using for i in range(x): where i is a variable and x is a number or iterating over a string or list. Eg. for i in colours: where colours is a lost
Arithmetic operators	The signs used to do maths. + - / * // (integer division) % (modulus division)
Logical operators	The Boolean operators AND, OR, NOT which are used in Python – and, or, not
Relational or comparison operators	The signs used when comparing values. < > <= >= == != (is not equal to)
Truth table	A table showing all possible combinations of inputs and outputs of a logic gate. The logic gates use the Boolean operators AND, OR, NOT.
Trace table	A technique used by programmers to track the changes in a variable as a program is run. Like using the debugger but by hand
Breakpoint	A 'mark' in a line of code where a debugger will pause to allow debugging to take place from that line