IGCSE 01 Data Representation

Hexadecimal | Octonary

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0

Binary to Denary

1	0	1	1	1
2^4	2^3	2^2	2^1	2^0

$1\times2^4+0\times2^3+1\times2^2+1\times2^1+1\times2^0 = 23$

Octonary to Denary

3	2	0	7
8^3	8^2	8^1	8^0

$3\times8^3+2\times8^2+0\times8^1+7\times8^0 = 1671$

Hexadecimal to Denary

3	A	F
16^2	16^1	16^0

$3\times16^2+10\times16^1+15\times16^0 = 943$

Denary to Binary

2 | 59 → 1
2 | 29 → 1
2 | 14 → 0
2 | 7 → 1
2 | 3 → 1
2 | 1 → 1
0

59 ≈ 111011

Denary to Octonary

8 | 1671 → 7
8 | 208 → 0
8 | 26 → 2
8 | 3 → 3
0

1671 ≈ 3207

Denary to Hexadecimal

16 | 943 → 15~F
16 | 58 → 10~A
16 | 3 → 3
0

943 ≈ 3AF

Denaty to Octonary

binary: 10111101

1	0	1	1	1	1	0	1

2	7	5

octonary: 275

Denary to Hexadecimal

binary: 10111101

1	0	1	1	1	1	0	1

C	E

octonary: 275

Overflow: a condition when the result of a calculation is too large to fit into the number of bits defined for storage

Binary Add

```
  1 0 1 1 1 0 1 0   186
+ 1 1 1 0 1 1 0 1   237
  1 1 1 1 1 0 0 0
1 1 0 1 0 0 1 1 1   423
```

unit of measurement	abbreviation	conversion
bit	b	1 bit
nibble		4 bits
Byte	B	8 bits
Kilobyte	kB	1024 bytes
Megabyte	MB	1024 kB
Gigabyte	GB	1024 MB
Terabyte	TB	1024 GB

HTML Color

#FFFFFF #333333 #FF00000 #00FF00 #0000FF #00FFFF #9324FC

color depth: **the number of bits** used to represent each pixel
black and white, **1bit** per pixel
4 color, **2 bits** per pixel
8 color, **3 bits** per pixel

Image resolution: **the number of pixels** that make up an image.
400*600 pixels

400 * 600 image, RGB 3 * 16 * 16 color depth, **file size**:
400 * 600 * 3 * ($\log_2256$) bits
= 240000 * 3 * 8 bits = 720000 byte
= 720000 / 1024 kB = 703 kB
= 703 / 1024 MB = 0.68MB

	R	G	B	range
hexadecimal	93	24	FC	00~FF
denary	147	35	252	0~255
binary	10010101	00100100	11111100	

Calculation of file size:
image file size:
image resolution(in pixels) * colour depth (in bits)
sound file size:
sample rate(in HZ) * sample resolution (in bits) * length of sample (in seconds)

binary usages: register, memory, Logic Gates, Boolean Algebra, Machine Language, Data Representation
hexadecimal usages: color in HTML, MAC address, assembly languages, machine code, IPv6.
why use binary store data?
1. a computer can only work with binary data
2. computers use switches/ logic gates
3. only use 2 states, On or Off, 1 or 0.
why use hexadecimal?
1. more **convenient** to use
2. one hex digit represent four binary digits
3. hex number is far easier for humans to remember, copy and work with.
why designer use hexadecimal?
1. Uses fewer characters // shorter
2. Easier to read / write / understand
3. Less likely to make mistakes // less error prone
4.Easier to debug

Logical shift:
left logical shift: multiplying by 2 for each shift
right logical shift: dividing by 2 for each shift
multiple shift

Bits shifted from the end of the register are lost and zeros are shifted in at the opposite end of the register

two's complement: represent positive and negative 8-bit binary integers

positive number:
sign bit 0, positive binary value
negative number:
sign bit 1
1. **write positive binary value**
2. **invert each binary value**
3. **add 1 to the number**

ASCII code
8 bit length
Standard ASCII code character set consists of 7-bits codes
Extended ASCII use **8 bit codes** give another 128 codes to allow for non-English alphabets.
Unicode
1. represent non-Western languages, such as Chinese or Japanese characters.
2. up to 32 bits per character

Sound
sampling resolution: the **number of bits per sample**.
sampling rate: the number of **sound samples** taken **per second**.

The greater the number of bits used to represent the amplitude, the greater the accuracy of the sampled sound.

Lossy and Lossless Compression
why compression?
1. **save storage** on devices
2. **reduce the time** taken to stream a music or video file
3. reduce the time taken **upload**, **download** or file across a network
4. reduce file size also **reduce costs**.
Lossy compression: The original file **cannot be reconstructed** once it has been compressed.
How lossy compression: the algorithm used int the lossy technique have to decide which parts the file need to be retained and which can be discarded
JPEG
1. reducing resolution or color depth
2. reducing sample rate or resolution
Lossless compression:
all the data from the original uncompressed file **can be reconstructed**.

Run-length encoding:
1. reducing the size of a string of adjacent, identical data items
2. the repeating unit is encoded into two values: first value represents number of identical data items I, second value represents code (such as ASCII) of data item.
usages: image, text, code.

IGCSE 02 Data transmission

Data Packets:
1. **packet header:**
IP address of the **sending station**
IP address of **receiving station**
the sequence **number of the packet**
packet size
2. **payload**: the actual data
3. **packet trailer:**
cyclic redundancy check (CRC)
a way of identifying the **end of the data packet**

Routers: used to control the path a data packet takes from sending station to receiving station

Packet Switching:
each data packet can take a **different route**;
each route taken is **independent of each other**.

Benefits of packet switching:
1. There is no need to tie up a **single communication line**.
2. It is possible to **overcome failed**, busy or faulty lines by simply rerouting packets.
3. It is relatively **easy to expand** package usage.
4. A **high data transmission rate** is possible.

Drawbacks of packet switching:
1. Packets **can be lost** and need to be re-sent.
2. The method doesn't work well with **real-time streaming** (for example, a live sporting event being transmitted over the internet).
3. There is a **delay** at the destination whilst the packets are being reordered.

Simplex: data can be sent in **one direction only**. (from computer to **printer**)
Half-duplex: data can be sent in **both directions by not at the same time** (**walkie-talkie**)
Full-duplex: data can be sent in **both directions at the same time** (**broadband internet connect**)
Serial data transmission: data is sent **one bit at a time over a single wire/channel.**
1. Less risk of **external interference** than with parallel.
2. More reliable transmission over **longer distances**.
3. Transmitted bits won't have the risk of being skewed.
4. Used if the amount of data being sent is relatively small, since transmission rate is **slower than parallel**.
5. Used to send data over long distances.
6. **Less expensive** than parallel due to fewer hardware requirements.

Parallel data transmission: **several bits of data** are sent down **several channels/wires** all at the same time
1. **Faster** rate of data transmission than serial, which makes it the preferred method where speed is important (such as internal connections in a computer).
2. Works well over **shorter distances**.
3. Due to several wires/channels being used, data can become skewed over long distances (no longer synchronised).
4. Easier to program input/output operations when parallel used. Preferred method when **sending large amounts of data**.
5. The most appropriate transmission method if data is **time sensitive**.
6. Requires more hardware, making it more **expensive** to implement than serial ports.

Parity checking: check whether data has been change or corrupted following data transmission

0	1	1	0	1	1	0	0

Even parity checking: an even number of 1-bits in the byte

1	1	1	0	1	1	0	0

Odd parity checking: an odd number of 1-bits in the byte

If **two of the bits change value** following data transmission, it may be impossible to locate the error using parity checking.

Checksum: check if data has been changed or corrupted following data transmission. (**send at the end of block data**)

Process:
1. calculated from the block of data
2. the calculation is done using an agreed algorithm
3. transmitted with the block of data
4. at the receiving end, the checksum is recalculated by the computer using the block of data
5. the re-calculated checksum is then compared to the checksum sent with the data block
6. if the two checksums are the same is correct

USB(Universal serial bus): a form of serial data transmission. Allow both half-duplex and full-duplex data transmission.
Process:
1. The computer automatically **detects that a device is present**.
2. The device is automatically recognized, and the appropriate **device driver software is loaded up**
3. Look for the device driver that **matches the device**.

Benefits:
1. Devices **automatically detected**. device driver automatically loaded up
2. become an **industry standard**
3. support **different data transmission rates**
4. no need external **power source**
5. **backward compatible**(old version still supported)

Drawbacks:
1. only support **maximum cable length** of 5m
2. early standard(v1) may not always supported
3. Even the latest version 3 (V3) and version 4 (V4) USB-C systems have a data transfer rate which is slow compared with, for example, Ethernet connections.

ARQs (Automatic Repeat Requests): a third way used to check data transmission
Process:
1. Uses acknowledgement / request and time-out
2. Error control protocol
3. Check performed on receiving data // error is detected by e.g. parity check, check sum
4. If error detected, request is sent to resend data // negative acknowledgement is used
5. Resend request is repeated till data is sent correctly / requests time out / limit is reached
6. Send acknowledgement that data is received // positive acknowledgement is used
7. If acknowledgement not received in set time data is resent

Echo check : when data is sent to another device, this data is sent back again to the sender.

Process:
1. a copy of data is sent back to the sender
2. returned data compare with the original data by the sender
3. if no difference, send without error
4. if difference, error occurred.

Check digits : calculated from all the other digits in the code.

Process:
1. A digit that is calculated from the data // uses modulo to calculate digit // valid description of modulo
2. It is appended / added to the data
3. Digit is recalculated when data is entered
4. Digits are compared to check for error

plaintext: the origin data
ciphertext: the encryption data

Symmetric encryption: use an encryption key. **The same key** is used to encrypt and decrypt the encoded message.
Drawback: keeping the encryption key a secret.

Asymmetric encryption: use **two keys called public key and private key**.
public key: made available to everybody
private key: only known to the computer user

Matching pairs (private and public keys) are generated by an **encryption algorithm.**

Increase the length of the key can make encryption more secure

IGCSE 03 Hardware (1)

Von Neumann architecture main novel features

1. The concept of a central processing unit (CPU or processor).
2. The processor was able to access the memory directly.
3. Computer memories could store programs as well as data.
4. Stored programs were made up of instructions which could be executed in sequential order.

Components of a typical CPU

Arithmetic Logic Unit(ALU):

1. internal part of the CPU that carries out **calculations** on data.
2. The **arithmetic part** uses the usual operators such as multiply, divide, add and subtract.
3. The **logic part** carries out comparisons such as 'equal to', 'grater than' and 'less than'.
4. Values need to be placed in the **accumulator** for calculations to be carried out.

Computers can have more than one ALU.
The ALU allows multiplication and division using shifting operators

Control Unit(CU):

1. **controls the flow of data** through the CPU.
2. also **controls the interactions** between the different parts of the CPU..
3. **Signals are generated** during the Fetch-Decode-Execute cycle to control all components of the computer.
4. **decode**

Registers:

1. internal memory locations within the CPU.
2. The **temporarily hold data** and instructions during processing
3. Registers are used to move data and instructions into and around the different components of the CPU

System clock:

1. used to produce timing signals on the control bus to ensure all functions are **synchronised**.
2. Changing clock speed can improve performance but there is always the risk of **overclocking** (which can lead to overheating and system crashes).

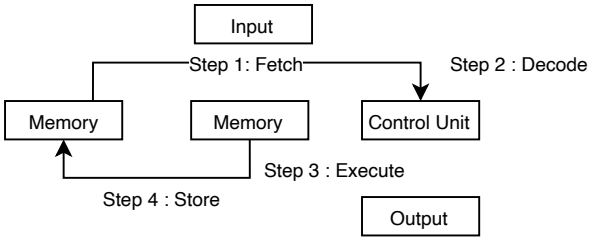
Buses:

1. connected to one another and this is usually done through buses.
2. A bus is a series of conductors, or pathways, which can be considered a sort of 'highway' for information. Three separate buses are used:
   1. The **dafa bus** carries the data.
   2. The **address bus** carries the memory address.
   3. The **control bus** carries the instructions.

Memory

How to speed up CPU Performance

1. increases the **processing speed** of the CPU
2. The **width of the address bus and data bus** increases the processing speed of the CPU
3. **Caches**, which store frequently used instructions and data, can speed up CPU performance. The larger the **cache memory size** the better the CPU performance.
4. Using a **different number of cores** can also improve CPU performance.



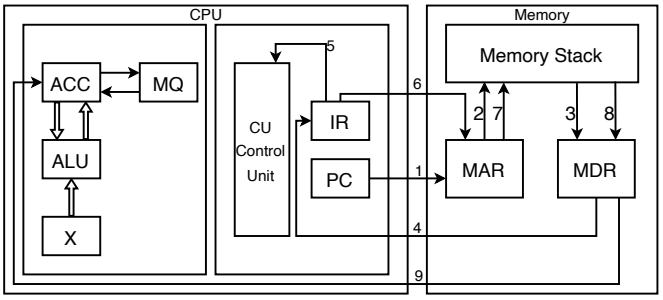
The Fetch-execute cycle:

Step 1 - **Fetch the instruction**: The CPU fetches the necessary data and instructions and stores them in its own internal memory locations (the IAS). To fetch the instruction the CPU uses the address bus.

Step 2 - **Decoding the instruction**: The CPU now needs to understand the instruction it has just fetched. To do this it needs to decode the instruction.

Step 3 - **Executing the instruction**

Now the CPU understands the instruction, it can execute the instruction.
Once the CPU has executed the instruction the cycle can begin again for the next instruction.



Fetch : PC → MAR → Memory → MDR → IR
Decode: IR → CU
Execute: IR → MAR → Memory → MDR → ACC

Representation of the fetch stage of the fetch-execute cycle:
MAR ← [PC]
PC ← [PC] + 1; MDR ← [[MAR]]
CIR ← [MDR]

Embedded System

An embedded system is a combination of hardware and software designed to carry out **a specific task**.

Microcontroller

Made up of a CPU with RAM, ROM and peripherals all embedded on **a single chip** to carry out a **specific task**.

Microprocessor

Integrated circuit consisting of CPU only (no peripherals).

System on a chip

May contain a microcontroller as one of its components; usually includes a CPU, memory, input/output (I/O) ports and secondary storage **all on a single chip**.

Embedded System benefits:

1. They are **small in size** and therefore easy to fit into devices.
2. Compared to other systems, they are relatively **low cost** to make.
3. They are usually **dedicated to one task** making for simple interfaces and often no requirement for an operating system.
4. They consume very **little power**.
5. They can be **controlled remotely** using a mobile phone, for example.
6. Very fast reaction to changing input (operate in real time and are feedback orientated); with mass production comes reliability.

Embedded System drawbacks:

1. It can be **difficult to upgrade** some devices to take advantage of new technology.
2. **Troubleshooting faults** in the device is a specialist task.
3. Although the interface can appear to be simple (such as a single knob) in reality it can be more confusing (for example, changing the time on a cooker clock can require several steps).
4. Any device that can be accessed over the internet is also **open to hackers viruses** and so on.
5. Due to the **difficulty in upgrading and fault finding**, devices are often just thrown away rather than being repaired (very wasteful).
6. Can **lead to environmental issues** created by an increase in the 'throw away' society if devices are discarded just because they have become out of date.

Examples of embedded systems:

1. **security systems** (use sensors, such as temperature, acoustic and pressure, to monitor for intruders and sound an alarm if necessary)
2. **set-top box to record and play back television programmers** (allow aerial, cable, satellite or Wi-Fi inputs and can be controlled remotely)
3. **lighting applications** (to control lighting depending on time of day, whether a room is occupied and brightness of ambient light; makes use of sensors and actuators to monitor and control lighting levels)
4. **vending machines** (monitor selection, money entered, tilting of machine and delivery of items using actuators and motors; uses sensors to detect tilting, temperature and to count money entered)
5. **washing machines** (selection is via keypad which allows wash program to be selected)
6. **motor vehicles** (fuel injection system, Global Positioning System (GPS) navigation, in-car entertainment, anti-lock braking system (ABS), and so on).

Instruction set

Instructions are a **set of operations** that need to be decoded in sequence;
each operation is made up of an **opcode** and an **operand**.
Instruction sets are **low level language** instructions that instruct the CPU how to carry out an operation.

IGCSE 03 Hardware (2)

Input Devices

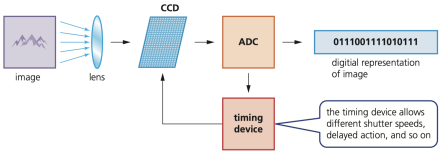
Barcode: A barcode is a series of dark and light parallel lines of varying thickness. The numbers 0 to 9 are each represented by a unique series of lines.

Barcode Scanner(readers):

1. the barcode is first of all **read by a red laser or red LED** (light emitting diode)
2. light is **reflected back off the barcode**; the dark areas reflect little or no light, which allows the bars to be read
3. the reflected light is **read by sensors** (photoelectric cells)
4. as the laser or LED light is scanned across the barcode, a pattern is generated, which is **converted into digital data** – this allows the computer to understand the barcode

Digital Cameras:

Digital images taken by cameras can easily be transferred to a computer (or other device) via **USB port**, **Bluetooth** (wireless transfer) or **memory card reader.**



Keyboard:

1. physical keyboards
2. virtual keyboards
3. touchscreen

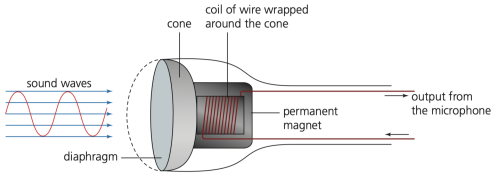
Entry of data via a keyboard is a slow process which is also prone to error and can lead to injuries such as **repetitive strain injury (RSI)**.

Microphones:

a number of applications:

1. **sensor** - detect sound in an intruder detection system
2. **input text into a computer** - particular benefit to a disabled person who cannot use a keyboard
3. **doing voiceovers on presentation slides**

Microphones convert sound into electric currents of varying amplitude. The electric current can be converted into digital data and then stored in a computer memory.



Optical mouse:

The optical mouse is an example of a **pointing device**. It uses tiny cameras and a red LED light source to allow the exact position of the mouse to be calculated.

Advantages of an optical mouse compared to a mechanical mouse:

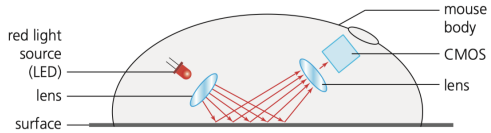
1. **No moving parts** therefore more reliable.
2. Dirt **can't get trapped** in any components.
3. **No need for special software.**

Advantages of a wired mouse (using USB) compared to a wireless mouse

1. Unlike Bluetooth, wired connections have **no signal loss**.
2. **Cheaper to use** (no need for batteries).
3. **Fewer environmental issues** (for example, disposal of batteries).

Scanners

2D scanners



Computers equipped with **optical character recognition (OCR)** software allow the scanned text to be converted into a **text file format**

usages:

1. **airports**: read passports enabling automatic border controls
2. **Scanning faces**: control entry to a building or as a security device on a smartphone to prevent unauthorised use.

3D scanners:

3D scanners scan solid objects and produce a 3D image that can then be used in computer-aided design (CAD) software or even sent to a 3D printer allowing the scanned object to be duplicated.

3D scanner technology uses lasers, X-rays, magnetic resonance or white light.

usages:

1. **tomography**: medical applications to build up images of parts of the human anatomy
2. **magnetic resonance imaging (MRI)** scanners use radio frequencies.

Touch screens:

Capacitive touch screens:

1. surface captive screens
2. projective capacitive screens: multi-touch facility (pinching and sliding) is allowed.

Infrared touch screens:

1. Uses a glass screen and an array of sensors and infrared transmitters.
2. Allows multi-touch facility.
3. Has good screen durability.

Resistive touch screen:

1. Made up of two layers of polymer and glass.
2. Low sensitivity and doesn't allow multi-touch facilities.
3. Has good resistance to dust and water.

Output Devices

Actuators: a mechanical or electromechanical device, such as a relay, solenoid or motor.

Light projectors:

Light projectors are used to project computer output onto a larger screen or interactive whiteboard;

Liquid crystal display (LCD) projector:

1. Uses many micro mirrors arranged on a DMD chip.
2. These mirrors can move according to the data sent to them from the computer.
3. Micro mirrors produce a greyscale image of the light source
4. A bright light is shone on the DMD chip passing through an RGB filter where the greyscale image is now converted into a full-colour image.

Advantages:

1. Gives a **sharper image** than DLP projectors.
2. Has **better colour saturation** than DLP projectors.
3. More **efficient** in its use of energy than DLP technology – consequently it generates less heat.

Disadvantages:

1. Although improving, the contrast ratios are not as good as DLPs.
2. Has a **limited life**
3. Since LCD panels are organic in nature, they tend to **degrade with time**

Digital light projectors (DLP):

1. A powerful beam of light is sent to a chromatic-coated mirror which splits the image into red, green and blue components.
2. The images are recombined using a prism which produces an enlarged full-colour image.

Advantages:

1. **Higher contrast ratios**.
2. **Higher reliability/longevity**.
3. **Quieter** running than LCD projector.
4. Uses a single DMD chip which equates to no issues lining up the images.
5. **Smaller and lighter** than LCD projectors.
6. It is better suited to dusty or smoky atmospheres than LCD projectors.

Disadvantages:

1. Image tends to suffer from '**shadows**' when showing a moving image.
2. Does not have **grey components** in the image.
3. The **colour definition** is frequently not as good as LCD projectors (that is, the colour saturation is not as good).

Printers:

Inkjet printers

Inkjet printers rely on **spraying liquid ink** droplets from a reservoir onto paper; they use either **thermal bubble** or **piezoelectric** technology to create the ink bubbles and droplets. Stepper motors move paper up a line at a time and the print head moves across the page left to right.

The inkjet ink cartridges and paper trays are **only suitable for relatively small print runs**

Laser printers

Laser printers rely on using **dry powder ink** (known as toner); this solid ink is melted onto the paper using a **fuser**. The position where text or images is to be printed is **charged negatively on a drum using a laser**. Positively charged ink then sticks to the areas of negative charge on the **drum** which is then transferred to a sheet of paper as the drum rotates. The **whole page is produced in one go**.

Ink/toner cartridges and paper trays are much larger than those used in inkjet printers; consequently, laser printers are more suitable for **large print runs**

3D printers:

3D printers are used to produce solid objects that actually work; the printers are based on inkjet and laser printer technology.

Direct 3D printing uses a print head moving left to right and up and down as it **builds up the thin layers**

Binder 3D printing works in a similar way to direct printing, except there are two passes of the print head for each layer; the first pass is dry powder and the second pass is a binding agent

usages:

1. **medicine**: prosthetic limbs and reconstructive surgery
2. **aerospace**: make light-weight parts
3. **fashion and art**: create one-off dresses
4. **sculptures**: make copies of rare paintings
5. **making parts for items**: vintage and veteran cars

LED screen

An LED screen is made up of many tiny light emitting diodes. Each LED is red, green or blue. By varying the electric current to each diode, its brightness is controlled which results in millions of different colours.

LED screens are used in large outdoor advertising displays and large scoreboards at sporting events.

LEDs are used to backlight LCD screens because:

1. they reach maximum brightness immediately
2. they produce a very white light which gives good colour definition
3. they last almost indefinitely and consume very little power.

LCD screen

LCD screens are made up of millions of tiny liquid crystals arranged as a matrix (array) of pixels. By varying the electric field to the liquid crystals their properties change.

Since LCDs do not produce any light, they need to be backlit with a light source, such as LEDs.

OLED screen (organic light emitting diodes)

1. allow very thin screens (2 mm or less in thickness), which means they can be formed into almost any shape
2. provides brighter colours than LED backlit LCD screens
3. allow for true black, unlike LCD
4. consume very little power.

Speakers

Loudspeakers produce sound from varying electric currents.

digital to analogue converter (DAC)

IGCSE 03 Hardware (3)

Sensors:

1. Sensors are input devices which read or measure physical properties from their surroundings.
2. Real data is analogue in nature; this means it is constantly changing and doesn't have a single discrete value. This is usually achieved by an analogue to digital converter (ADC). This device converts physical values into discrete digital values.

Sensors

Sensor	Description	Example applications
Temperature	Measures temperature of the surroundings by sending signals; these signals will change as the temperature changes.	1. control central heating system 2. control/monitor chemical processes 3.control/monitor temperature in a greenhouse
Moisture	Measures water levels in, for example, soil (it is based on the electrical resistance of the sample being monitored).	1. control/monitor moisture levels in soil 2. monitor moisture levels in a food processing factory
Humidity	Slightly different to moisture; measures the amount of water vapour in, for example, a sample of air (based on the fact that the conductivity of air will change depending on amount of water present).	1. monitor humidity levels in a building 2. monitor humidity levels in a factory manufacturing microchips 3. monitor/control humidity levels in the air in a greenhouse
Light	Use photoelectrical cells which produce an output (in the form of an electric current) depending on the brightness of the light.	1. switch street lights off or on depending on light levels 2. switch on car headlights automatically when it gets dark
Infrared (active)	Use an invisible beam of infrared radiation picked up by a detector; if the beam is broken, then there will be a change in the amount of infrared radiation reaching the detector (sensor).	1. turn on car windscreen wipers automatically when it detects rain on the windscreen 2. security alarm system (intruder breaks the infrared beam)
Infrared (passive)	Measure the heat radiation given off by an object; for example the temperature of an intruder or the temperature in a fridge.	1. security alarm system (detects body heat) 2. monitor the temperature inside an industrial freezer or chiller unit
Pressure	A transducer that generates different electric currents depending on the pressure applied.	1. weigh lorries at a weigh station 2. measure the gas pressure in a nuclear reactor
Acoustic/ sound	Basically microphones that convert detected sound into electric signals/pulses.	1. pick up the noise of footsteps in a security system 2. detect the sound of liquids dripping at a faulty pipe joint
Gas	Most common ones are oxygen or carbon dioxide sensors; they use various methods to detect the gas being monitored and produce outputs which vary with the oxygen or carbon dioxide levels present.	1. monitor pollution levels in the air at an airport 2. monitor oxygen and carbon dioxide levels in a greenhouse 3. monitor oxygen levels in a car exhaust
pH	Measure change in voltages in, for example, soil depending on how acidic the soil is.	1. monitor/control acidity levels in soil 2. control acidity levels in a chemical process
Magnetic field	Measure changes in magnetic fields the signal output will depend on how the magnetic field changes.	1. detect magnetic field changes (for example, in mobile phones and CD players) 2. anti-lock braking systems in cars
Accelerometer	Measure acceleration and motion of an application, that is, the change in velocity (a piezoelectric cell is used whose output varies according the change in velocity).	1. measure rapid deceleration in cars, and apply airbags in a crash 2. change between portrait and landscape mode in mobile phones
Proximity	Detect the presence of a nearby object.	detect when a face is close to a mobile phone screen and switch off screen when held to the ear
Flow (rate)	Measure the flow rate of a moving liquid or gas and produce an output based on the amount of liquid or gas passing over the sensor.	1. in respiratory devices and inhalers in hospitals 2. measure gas flows in pipes (for example, natural gas)
Level	Use ultrasonics (to detect changing levels in, for example, a tank) or capacitance/ conductivity to measure static levels (for example, height of water in a river) note level sensors can also be optical or mechanical in nature.	1. monitor levels in a petrol tank in a car 2. in a pharmaceutical process where powder levels in tablet production need to be monitored 3. leak detection in refrigerant (air conditioning)

difference between primary memory and storage device:

primary memory:

1. Directly addressable by the CPU
2. Contains RAM, ROM and cache memory

secondary storage:

1. **Not directly addressable** by the CPU
2. All are **non-volatile** devices
3. Can be external or internal to the computer
4. Examples include **HDD, SSD, DVD, memory stick, Blu-ray disc**

random access memory(RAM):

1. **can be written to or read from**, and the data can be changed by the user or the computer (i.e. it is a temporary memory)
2. used to **store data**, files, part of an application or part of the operating system **currently in use**
3. it is **volatile**, which means memory contents are lost when powering off the computer.

Dynamic RAM (DRAM):

1. needs to be **constantly refreshed**
2. If it **wasn't refreshed**, the capacitor's charge would leak away very quickly leaving every capacitor with the value 0.

Dynamic DRAM advantages over SRAM:

1. they are **much less expensive** to manufacture than SRAM
2. they consume **less power** than SRAM
3. they have a **higher memory capacity** than SRAM.

Static RAM(SRAM):

1. A major difference between SRAM and DRAM is that SRAM doesn't need to be constantly **refreshed**.
2. It makes use of flip flops, which hold each bit of memory.

Differences between DRAM and SRAM

DRAM	SRAM
consists of **a number of transistors** and capacitors	uses **flip flops** to hold each bit of memory
needs to be **constantly refreshed**	doesn't need to be constantly refreshed
less expensive to manufacture than SRAM	has a faster data access time than DRAM
has a **higher memory capacity** than SRAM	**CPU memory cache** makes use of SRAM
main memory is constructed from DRAM	
consumes **less power** than SRAM	

read-only memory (ROM):

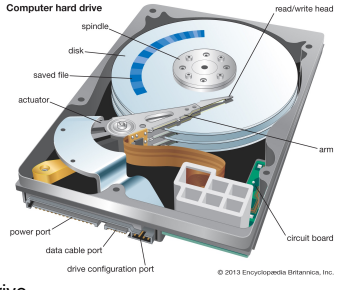
1. they are **non-volatile** (the contents are not lost after powering off the computer)
2. they are **permanent memories** (the contents cannot be changed or written to by the user, the computer or any application/program)
3. the contents can **only be read**
4. they are often used to store data that the computer needs to access when powering up for the first time (the basic input/output system (**BIOS**)); these are known as the start-up instructions (or bootstrap)

RAM	ROM
temporary memory device	**permanent** memory device
volatile memory	**non-volatile** memory device
can be written to and read from	data stored cannot be altered
used to store data, files, programs, part of OS currently in use	always used to store BIOS and other data needed at start up
can be increased in size to improve operational speed of a computer	

Secondary and off-line storage:

1. storage devices that are **not directly addressable** by the CPU.
2. **non-volatile devices** that allow data to be stored as long as required by the user.
3. data access time is considerably longer than with RAM or ROM
4. All applications, the operating system, device drivers and general files are stored on secondary storage.

Magnetic storage:



1. Data is stored in a digital format on the magnetic surfaces of the disks (or platters, as they are frequently called).
2. The hard disk drive will have **a number of platters** that can **spin** at about 7000 times a second.
3. **Read-write heads** consist of electromagnets that are used to read data from or write data to the platters.
4. A number of read-write heads can access all of the surfaces of the platters in the disk drive.
5. Data is stored on the surface in **sectors** and **tracks**.
6. A sector on a given track will contain a fixed number of bytes.
7. hard disk drives have very **slow data access** when compared to, for example, RAM.
8. The effects of latency then become very significant. Latency is defined as the time it takes for a specific block of data on a data track to rotate around to the read-write head.

IGCSE 03 Hardware (4)

Solid state drivers (SSD)
1. they are **more reliable** (no moving parts to go wrong)
2. they are considerably **lighter** (which makes them suitable for laptops)
3. they don't have to '**get up to speed**' before they work properly
4. they have a lower power consumption
5. they run **much cooler** than HDDs (both these points again make them very suitable for laptop computers)
6. because of no moving parts, they are very **thin**
7. data access is **considerably faster** than HDD.

Benefits of SSDs compared to HDDS:
1. More reliable (no moving parts).
2. Much lighter weight.
3. No need to 'get up to speed' before data access.
4. Less power consumption.
5. Run much cooler.
6. Very thin due to solid-state technology.
7. Much faster data access.

Drawbacks of SSDs compared to HDDs:
1. Longevity (SSD endurance) is still an issue (but this situation continues to improve).
2. The memory chips in a solid-state storage device have a limited number of write cycles – this can lead to unrecoverable data loss.
3. If the controller chip, memory cache, or one of the NAND memory chips has been damaged, it may be impossible to recover the data.

Memory sticks, **flash memories**, **SD cards** and **SSDs** all use solid-state technology.

Memory sticks/flash memories: They usually connect to the computer through the USB port. Their main advantage is that they are very small, lightweight devices, which make them very suitable as a method for transferring files between computers.

USB benefits:
1. It is a **universal standard**
2. It can't be inserted the wrong way around
3. **Supports different transmission speeds**
4. Automatically detects if correct driver installed

CD/DVD disks: CDs and DVDs are described as optical storage devices. Laser light is used to read and write data to and from the surface of the disk.

similarities between a CD and a DVD:
1. Both need a red laser to read/write data
2. Both are spun to be read
3. Both use spiral tracks for data
4. Both are optical storage
5. Both are off-line storage // both non-volatile
6. Both use pits and lands to store data

difference between CD and DVD:
1. DVD can be dual layer, but CD can only be single
2. DVD has higher storage capacity
3. DVD has a shorter wavelength laser
4. DVD are spun faster
5. DVDs have a higher data transfer rate

Blu-ray discs： optical storage media

main differences between DVD and Blu-ray：
1. a blue laser, rather than a red laser, is used to carry out read and write operations; the wavelength of blue light is only 405 nanometres (compared to 650 nm for red light)
2. using blue laser light means that the 'pits' and 'lands' can be much smaller; consequently, Blu-ray can store up to five times more data than normal DVD single-layer Blu-ray discs use a 1.2 mm thick polycarbonate disk; however, duallayer Blu-ray and normal DVDs both use a sandwich of two 0.6 mm thick disks
3. Blu-ray disks automatically come with a secure encryption system that helps to prevent piracy and copyright infringement
4. the data transfer rate for a DVD is 10 Mbps and for a Blu-ray disc it is 36 Mbps.

Virtual Memory
RAM is known as the physical memory and virtual memory is the **RAM plus swap space**
Part of memory mapping is called **paging**, which is used by memory management to store and retrieve data (a **page** is a fixed length **contiguous** block of data utilised in virtual memory systems).
Virtual memory gives the illusion of unlimited RAM; even when RAM is 'full', pages of data can be moved to and from HDD/SSD to give the illusion that RAM is always available.

Benefits of virtual memory
1. With virtual memory, programs can be **larger than physical RAM and still be executed**.
2. Virtual memory **reduces the need to buy and install extra RAM** (which is expensive).

Routers
Routers enable **data packets** to be routed between different networks, for example a **local area network (LAN)** to a **wide area network (WAN)**.

Routers take data transmitted in one format (protocol) from network 'A' and convert the data to another format (protocol) that network 'B' understands. This allows communication between networks to take place.

Cloud storage
Cloud storage is the storing of vast quantities of data on remote physical servers.

three types of cloud storage
1. Public cloud – the client and cloud storage provider are different companies.
2. Private cloud – a dedicated system behind a firewall where the client and storage provider operate as a single entity.
3. Hybrid cloud – a combination of public and private cloud provider where the most sensitive data is stored on the private cloud.

Data redundancy
When using cloud storage, the same data is stored on more than one server in case of maintenance/repair

Benefits of cloud storage
1. Customer/client files stored on the cloud can be **accessed at any time** from any device anywhere in the world provided internet access is available.
2. There is **no need** for a customer/client to carry an **external storage device** with them, or even use the same computer to store and retrieve information.
3. The cloud provides the user with **remote back-up** of data with obvious benefits to alleviate data loss/ disaster recovery.
4. If a customer/client has a failure of their hard disk or back-up device, cloud storage will allow **recovery of their data**.
5. The cloud system offers almost **unlimited storage capacity**.).

Drawbacks of cloud storage
1. If the customer/client has a slow or **unstable internet connection**, they would have many problems accessing or downloading their data/files.
2. **Costs** can be high if large storage capacity is required; it can also be expensive to pay for high download/ upload data transfer limits with the customer/client internet service provider (ISP).
3. The potential failure of the cloud storage company is always possible – this poses a risk of **loss of all back-up data**.
4. **Data security issues** – how safely stored and protected is the data from hacking, natural disasters and malware?

Network hardware
network interface card (NIC): allow a device to connect to a network.
The NIC contains the **Media Access Control (MAC)** address, generated at the manufacturing stage.
Wireless NICs (WNICs):
plug into the USB port or can be part of an internal integrated circuit.

MAC address: Media Access Control addresses
MAC addresses identify a device connected to a network.
They are made up of 48 bits written in groups of six hex digits
NN - NN - NN - DD - DD - DD
manufacturer's code **device serial number**

IP Address: Internet Protocol addresses
When a device connects to a network, a router assigns the device an Internet Protocol (IP) address, via a Dynamic Host Configuration Protocol (DHCP) server, which is **unique to that network**.

two versions of IP address:
1. **IPv4** (32-bit address with the format A.B.C.D where A, B, C and D can take the values 1 to 255; for example, 215.180.1.80)
2. **IPv6** (128-bit address with the format eight groups of four hex digits; for example, A8FB:7A88:FFF0:0FFF:3D21:2085:66FB:F0FA).

Differences between Dynamic and Static IP Address

Dynamic IP Address	Static IP Address
Changes every time a device connects to a network.	**Permanently** assigned.
Greater privacy since it changes each time a user logs on.	Since static IP addresses don't change, it allows each device to be **fully traceable**.
Dynamic IP addresses can be an issue when using, for example, Voice over Internet Protocol (VoIP) since this type of addressing is less reliable as it can disconnect and change the IP address causing the VoIP connection to fail.	Allows for **faster** upload and download **speeds**.
	More **expensive** to maintain since the device must be constantly running so that information is always available.

Differences between MAC and IP Address

MAC Address	IP Address
Identifies the **physical address** of a device on the network.	Identifies the **global address** on the internet.
Unique for device on the network	May not be unique.
Assigned by the manufacturer of the device and is part of the NIC.	Dynamic IP address is assigned by the ISP using DHCP each time the device connects to the Internet (see later).
Can be universal or local.	Dynamic IP addresses change every time a device connects to the internet; static IP addresses don't change.
When a packet of data is sent and received, the MAC address is used to identify the sender's and recipient's devices.	Used in routing operations as it specifically identifies where the device is connected to the internet.
Uses 48 bits.	Uses either 32 bits (IPv4) or 128 bits (IPv6).
Can be UAA or LAA.	Can be static or dynamic.

IGCSE 04 Software

SystemSoftware

1. Compilers
2. Linkers
3. Device Drivers
4. Operating system(OS)
5. Utilities

features: (provide the services that the **computer requires**)

1. Controls and manages the operation of the computer **hardware**.
2. Provides a platform on which all **software can run properly**.
3. Provides a **human computer interface** (HCI).
4. Controls the allocation and usage of **resources** (software and hardware).

Application Software

1. Spreadsheet
2. WordProcessor
3. Database
4. Editing software
5. Internet browser

features: (provide the service that the **user requires**)

1. Used to perform **various tasks** on a computer.
2. Allows the user to perform **specific tasks** on a computer.
3. Meets the **requirements of the user**.

Utility programs:

provides a number of useful programs to **protect the computer** and the user and also give the user software tools to carry out some of the **day-to-day maintenance**.

1. Virus checker
2. Defragmenter
3. Disk repair
4. File compression
5. Back-up software
6. Security
7. Device drivers
8. Screensavers

Operating System

1. **handling interrupts**
2. **managing multitasking** (carry out more than one task simultaneously)
   1. all resources are allocated specific processor time
   2. all processes can be interrupted as and when necessary
3. **managing memory**
   1. manage the data between RAM and HDD/SSD
   2. protecting two applications using the same memory at the same time
4. **providing an interface**
5. **managing system security**
   1. integrity, confidentiality and availability of data
6. **managing files**
   1. maintains file directories
   2. file name conventions
7. **managing user account**
   1. user login
   2. user's data store in separate part of memeory
8. **managing peripherals and drivers**
   1. manage queues and buffers to ensure data is being handled correctly
9. **providing a platform for running applications**

Running of applications

(Basic Input Output System)**BIOS**: a type of of firmware. provide low-level control of devices.

1. BIOS load part of operating system into RAM
2. Apps Apps are under the control of the operating system and need to access system software, such as device drivers.

Interrupts

a **signal** send from a device or software to the microprocessor. cause the microprocessor to temporarily stop what it is dong so it can service the interrupt.

cause of interrupt:

1. **Timing single** 2. **Input/Output process** 3. **Hardware fault** 4. **User interaction** 5. **Software error**

examples:

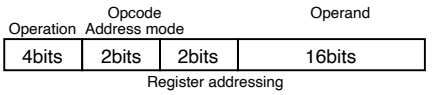
1. software interrupts
   1. divide by zero error
   2. can't find .exe file
   3. two process trying to access the same memory location at the same time
2. hardware interrupts
   1. printer has paper jam
   2. printer run out of ink
3. timing single error
   1. clock issue and operations are not synchronised
4. input/output hardware process
   1. HDD requesting new data
5. user interaction
   1. pressing keyboard keys
   2. clicking a mouse button

Assembly Language

Written using mnemonics and labels.
Needs translation before execution.

Machine Code

Written in binary.
Can be executed straight away.



High-level language

easy and quick to develop and maintain programs

Basic, Python, Java

Low-level language

develop special routings that use of memory. the computer's instruction set and hardware

assembly language, machine code.

Advantage and disadvantage of High-level and Low-level language

	High-level language	Low-level language
advantage	1.Independent of the type of computer being used. 2. **Easier to read, write and understand** programs. 3. **Quicker to write** programs. 4. Programs are easier and quicker to **debug**. 5.Easier to **maintain** programs in use.	1. Can make use of **special hardware**. 2. Can make use of special machine **dependent instructions**. 3. Code doesn't take up much **space** in primary memory. 4. Code **performs** a task very **quickly**.
disadvantage	1. Programs can be **larger**. 2. Programs can take **longer to execute**. 3. Programs may not be able to make use of special hardware.	1. It **takes longer to write and debug** programs. 2. Programs are more **difficult to understand**.

Translators

Computers use programs with binary instructions so programs must be translated into binary for the computer to follow them. Needs translation before execution.

Compiler

1. Translates a **high-level language program into machine code** in **one go**.
2. An **executable file** of machine code is produced.
3. One high-level language statement can be translated into several machine code instructions.
4. Once compiled, **programs are run without the compiler**.
5. A compiled program is usually distributed for general use.
6. If errors are detected, **an error report is produced** (instead of a compiled program).

Interpreter

1. Executes a high-level language program **one statement at a time**.
2. No executable file of machine code is produced.
3. One high-level language program statement may require **several machine code instructions** to be executed.
4. Interpreted programs **cannot be run without the interpreter**.
5. An interpreter is often used when a program is being developed.
6. If an error is **detected in a statement**, execution stops and an error message is output.

Assembler

1. Translates a low-level assembly language program into machine code.
2. An executable file of machine code is produced.
3. One low-level language statement is usually translated into one machine code instruction.
4. Assembled programs are used without the assembler.
5. An assembled program is usually distributed for general use.

Advantage and disadvantage of interpreter and compiler

	interperter	compiler
advantage	Easier and quicker to **debug**, test and edit programs during development.	A compiled program: 1. can be **stored ready for use** 2. can be **executed without the compiler** 3. takes up **less space in memory** when it is executed 4. is **executed** in a **shorter time**
disadvantage	Programs: 1. **cannot be run without the interpreter** 2. can take **longer to execute.**	Takes **longer to write, test and debug** programs during development.

Integrated development environment(IDE)

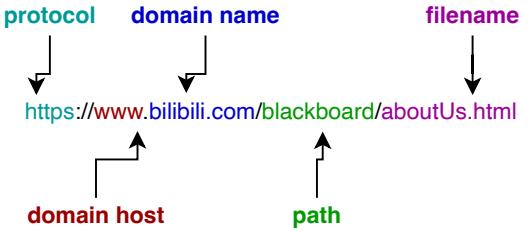
a suite of software development tools used by programmers to aid the writing and development of programs.

1. code editor
2. translator
3. runtime and debugger
4. error diagnostics
5. auto-completion
6. auto-correction
7. auto-documenter and pretty printing

IGCSE 05 The Internet and its uses(1)

Internet	World Wide Web
Users can send and receive **emails**.	A collection of multimedia web pages and other information on **websites**.
Allows **online chatting** (via text, audio and video).	http(s) protocols are written using **hypertext mark-up language(HTML)**.
Makes use of transmission protocols **(TCP)** and internet	**Uniform resource locators(URL)** are used to specify the location of web pages.
A worldwide collection of interconnected networks and devices.	Web resources are accessed by **web browsers**
	WWW uses the internet to access information from web servers.

URLs(Uniform resource locators):
text address used to access websites



http and https
http: Hypertext transfer protocol (http) is a set of rules that must be obeyed when transferring files across the internet.
https: http with secure

Web browsers
Browsers interpret (translate) HTML from websites and show the results of the translation (either as a website page or play multimedia).
web browsers functions:
1. a **home page** and **address bar**
2. the ability to store favourite websites and web pages (**bookmarks**)
3. keeping a history of websites visited (**user history**)
4. the ability to allow the user to **navigate forwards and backwards** through a website
5. allowing many web pages to be open at the same time by using **multiple tabs**
6. making use of **cookies**
7. using **hyperlinks** to navigate between websites
8. data stored as a **cache**
9. make use of JavaScript.

DNS
domain name server (DNS) is used to find the IP address from the domain name in the URL typed into the browser window.

How web pages are located, retrieved and displayed:
1. The user opens their browser and types in the URL and the browser **asks the DNS server for the IP address of the website**.
2. if DNS server can't find in its database or its cache, so it sends out a request to DNS server
3. The DNS server finds the URL and can map it to this IP address is sent back to the DNS server which now puts this IP address and associated URL into its **cache/database**.
4. This IP address is then sent back to the user's computer.
5. The computer now **sets up a communication** with the website server and the required pages are downloaded. The computer's browser interprets the HTML, which is used to structure content, and then **displays the information** on the user's computer.Cookies are small files or code stored on a user's computer

Cookies
Cookies are small files or code **stored on a user's computer**. Cookies are **sent by a web server** to the browser on a user's computer.

Cookies functions:
1. saving personal details
2. tracking user preferences
3. holding items in an online shopping cart
4. storing login details

Session cookie features:
1. Stored **temporarily** on the user's computer.
2. Once the browser is closed, the website session ends and the cookie is deleted.

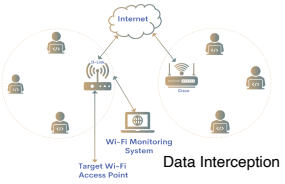
Persistent cookie features
1. Remember user's log in details.
2. Cookies are **stored on user's hard drive** until **expiry date** reached or user deletes them.
3. Remain in operation even after browser closed or website session terminated.

Digital currency
Digital currency exists purely in a digital format and has **no physical form** unlike fiat currency
Cryptocurrency is a type of digital currency that overcomes **security** and **confidentiality** issues.

Blockchaining
1. **decentralised database**: when a new transaction takes place, all networked computers in the system get a copy of the transaction, removing security risks such as **hacking**.
2. **block**: contains **data**, **a new hash value**, **a previous hash value** pointing to the preceding block.
3. **proof-of-work**: used to prevent high speed number crunching from altering all of the block hash values by a cybercriminal.

cryptocurrency uses:
1. smart contracts
2. in research – for example, development of new drugs
3. in politics
4. in many areas of education.

CyberSecurity threats
1. brute force attacks
2. data interception
3. distributed denial of service (DDoS) attacks
4. hacking
5. malware
6. phishing
7. pharming
8. social engineering.



Data Interception

Brute Force attacks:
Brute Force attacks is a method where all combinations of letters, numbers and other symbols are tried to generate passwords. **longer**, **more complex**, **passwords** make the task of the cybercriminal much harder

Data Interception:
Data interception is the stealing of data by tapping into a network.
packet sniffers: all data packets on a network and read the data being moved across the networks.
War driving(access point mapping): intercepts Wi-Fi (wireless) signals.

Security Threats (Hacking)
Hacking: the act of gaining illegal **access to a computer system without the user's permission**.

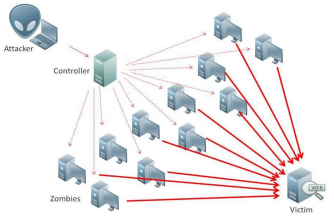
Hacking Threads:
1. identity theft or gaining of personal information
2. data can be deleted, passed on, changed or corrupted.

Prevents:
1. firewalls
2. change strong password
3. anti-hacking software

DDoS(Distributed Denial of Service attack)
DoS(Denial of Service attack): attempt at **preventing users from accessing part of a network**, notably an internet server.

Prevent:
1. using an up-to-date malware checker
2. setting up a firewall
3. applying email filters

What happen in DoS:
1. Many requests are sent from a computer
2. Requests are sent to the webserver
3. The webserver becomes flooded with traffic
4. The webserver cannot handle the requests / fails
5. he website can no longer be accessed
6. Attack maybe distributed



DDos attack

DoS signs:
1. slow network **performance**
2. **inability** to access certain website
3. large amounts of **spam email**

Security Threats (Malware)
Viruses – programs (or program code) that can **replicate/copy themselves** with the intention of **deleting or corrupting files, or causing the computer to malfunction**. They need an active host program on the target computer or an operating system that has already been infected before they can run. virus often **sent as email attachments**, **reside on infected websites** or on **infected software downloaded** to the user's computer.
Worms – these are types of standalone viruses that can **replicate themselves** with the intention of **spreading to other computers**; they often networks to search out computers with weak security that are prone to such attacks
Trojan horses – these are malicious programs often disguised as legitimate software; they **replace all or part of the legitimate software** with the intent of carrying out some harm to the user's computer system
Spyware – software that **gathers information by monitoring**, for example, all the activity on a user's computer; the gathered information is then **sent back to the person who sent the software** (sometimes spyware monitors key presses and is then referred to as key logging software)
Adware – software that floods a user's computer with unwanted advertising; usually in the form of pop-ups but can frequently appear in the browser address window redirecting the browser to a fake website which contains the promotional adverts
Ransomware – programs that **encrypt the data on a user's computer**; a decryption key is sent back to the user once they pay a sum of money (a ransom); they are often sent via a Trojan horse or by social engineering

IGCSE 05 The Internet and its uses(2)

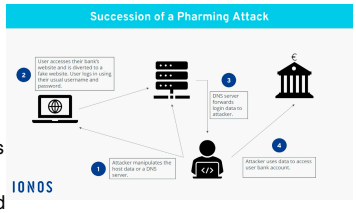
Phishing occurs when a cybercriminal sends out **legitimate-looking emails** to users. The emails may contain links or attachments that, when initiated, **take the user to a fake website**; or they may **trick the user into responding with personal data**

Pharming is malicious code installed on a user's computer or on an infected website. The code **redirects the user's browser to a fake website** without the user's knowledge.

Phishing

Phishing and Pharming Similarity:
1. Both are designed to **steal personal data**
2. They both **pose as a real company**/ perso

Phishing and Pharming Differences:
1. Pharming uses **malicious code installed on hard drive**
2. Phishing is **in form of an email**
3. phishing requires use to follow a link / open an attachment



Pharming

Prevent phishing attacks:
1. be aware of new phishing scams
2. not to click on any emails links
3. run anti-phishing toolbars on browsers
4. always look out for https
5. ensure up-to-date browser. run a good firewall

Prevent pharming attacks:
1. use **anti-virus software**
2. **modern browser** alert user
3. **check the spelling** of websites
4. use of **https**

Social engineering

Social engineering occurs when a cybercriminal creates a social situation that can lead to a potential victim 'dropping their guard'.

Instant messaging: Malicious links

Scareware: pop-up message with virus

Emails/phishing scams: opens a link in the email, redirects their browser to a fake website

Baiting: malware-infected memory stick

Phone calls: download some special software

Keep data safe from security threats

Access level:
user accounts control a user's rights, different levels of access for different people.

Anti-malware

Anti-virus: must be **kept thoroughly up to date** and should run in the background to maintain their ability to **guard against being infected** by such malware

Anti-virus features:
1. **check** software or files **before run**
2. **compares** a possible vires against a **known database**
3. carry out heuristic checking
4. allow user to automatically or decision to delete
5. needs to be kept up to data
6. full system check

Anti-spyware: detects and removes spyware programs installed illegally on a user's computer system,

Anti-spyware Feature:
1. detect and remove spyware
2. prevent a user from downloading spyware
3. encrypt files
4. encryption of keyboard
5. block access to a user's webcam
6. scans for signs that user's personal information has been stolen

Authentication: refers to the ability of a user to prove who they are.
Passwords and user names:
Passwords are used to restrict access to data or systems. They should be hard to crack and changed frequently to retain any real level of security.
Biometrics: Biometrics relies on certain unique characteristics of human beings

Two-step verification

Two-step verification is used as a method of authentication where **two different types of authentication** are needed to identify someone

Automatic software updates

Automatic updates of software keep a device secure. The updates will contain patches that could include updated virus checkers, software improvements and bug fixes.

Check spelling and tone of communication and of URL links

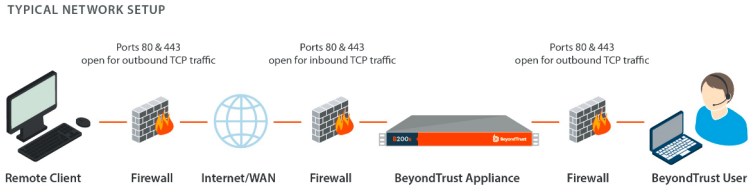
actions when receive an email:
1. Look out for suspicious links
2. Check the spelling in the email itself and any links
3. Check the tone of the message and language used
4. Check email addresses

Biometric technique	Benefits	Drawbacks
fingerprint scans	it is one of the most developed biometric techniques Very **easy to use** relatively small storage requirements for the biometric data created	for some people it is **very intrusive**, since it is still related to criminal identification it can make **mistakes** if the skin is dirty or damaged
retina scans	very **high accuracy** there is no known way to replicate a person's retina	it is **very intrusive** it can be relatively **slow** to verify retina scan with stored scans very **expensive** to install and set up
face recognition	**non-intrusive** method relatively **inexpensive** technology	it can **be affected** by changes in lighting, the person's hair, change in age, and if the person is wearing glasses
voice recognition	**non-intrusive** method verification takes less than 5 seconds relatively **inexpensive** technology	a person's voice can be **easily recorded** and used for unauthorised access **low accuracy** an illness such as a cold can change a person's voice, making absolute identification difficult or impossible

Keep data safe from security threats (Firewall)

Firewall Task:
1. **Monitors traffic** coming into and out of the computer
2. **Checks** that the traffic meat any criteria
3. **Blocks** any traffic that does not meet the criteria
4. Allows a set **blacklist**
5. Can **close certain ports**

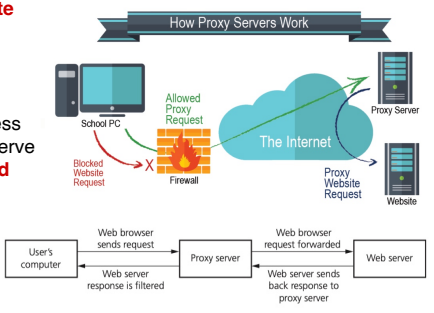
Firewall Feature:
1. can help **prevent hacking**
2. can **set criteria**
3. can **monitor** incoming and outgoing traffic
4. can check whether traffic meets
5. can **rejects** any traffic that does not meet



Keep data safe from security threats (Proxy Server)

Proxy Servers: act as an **intermediate** between the user and a web server

Proxy Server Features:
1. allow internet traffic to be filtered.
2. keeps users' **ip address secret**
3. **block** request from certain IP address
4. **prevents direct access** to a web serve
5. attack hits the **proxy server instead**
6. can also act as firewalls



Privacy settings

Privacy settings are controls available on web browsers, social networks and other websites; they are designed to limit who can access and see a user's personal profile (data)

Privacy settings Features:
1. **'do not track' setting**: stops collecting browsing data
2. check to see if the payment methods have been stored on websites
3. privacy options (**browsing history, storing cookies**)
4. advertising opt-outs preventing unsolicited adverts from websites
5. preventing **apps sharing your location**.

SSL(Secure Sockets Layer): a type of protocol - a set of rules used by computers to communicate with each other across a network

SSL certificate: a form of **digital certificate** which is used to **authenticate a website**.

SSL used:
1. online banking
2. online shopping
3. sending and receiving emails
4. using cloud storage facilities
5. used in instant messaging
6. social network

IGCSE 06 Automated and emerging technologies(1)

Advantage and disadvantage of automated systems

Application	Advantages of using robots in the application	Disadvantages of using robots in the application
Industry		
1. **Welding car bodies** and spray painting body panels. 2. Manufacturing **microchips** or **electrical goods.** 3. Makes use of end-effectors to do many **different tasks**. 4. Used in many **production facilities** (car manufacturing, bottling/ canning, testing circuit boards and so on).	1. Robots can work in **conditions that may be hazardous** to humans (noisy, dusty, chemicals and so on). 2. Robots can **work 24/7 with no breaks** except for occasional maintenance. 3. Using robots is **less expensive in the long run**. 4. Robots are usually **more productive** than humans. 5. In manufacturing, using robotics usually produces a **more consistent product**. 6. Robots are better suited to **boring and repetitive tasks**.	1. It can be difficult to get the robot to handle **'non-standard' tasks** without some human intervention. 2. Using robots can lead to **higher unemployment**. 3. **Risk of deskilling** since the robots take over tasks previously done by humans. 4. Factories can be moved overseas (advantage to company but a **disadvantage to the workforce**); it is relatively easy to dismantle robots and reassemble them in another country. 5. Robots are **expensive to buy** and set up initially.
Transport		
Autonomous cars, vans, buses, trams and trains.	1. **Safer** since human error is removed when operating vehicles. 2. **Better for the environment** since vehicles will operate more efficiently and energy consumption is minimised. 3. Leads to **less traffic congestion** as autonomous road vehicles can move more efficiently in cities and on motorways at busy times (due to increased lane capacity). 4. **Stress-free environment** for drivers and passengers. 5. Improves **punctuality and frequency of public transport**, such as buses, trams and trains. 6. **Reduction in running costs** (due to more efficient operation). 7. Easier to **alter** the bus, tram or train **schedule** at short notice (if some event makes this necessary).	1. Very **expensive to set up** in the first place (high technology requirements). 2. Needs **constant maintenance** to work effectively, securely and safely (cleaning of sensors and cameras). 3. Ensuring the **good behaviour of passengers** (especially at peak times) can lead to problems (for example, jamming doors, too many people trying to board at once and so on). 4. Need a good, reliable control system (for example, CCTV); this can be **expensive to maintain**. 5. **Emergency situations** may be difficult to deal with. 6. Driver and passenger **reluctance to use the new technology**.
Agriculture		
1. Harvesting. 2. Weed control (AI can distinguish between weed and crop). 3. Phenotyping – observing plant growth/health. 4. Seed planting and fertiliser spraying using drones. 5. Automatic fruit picking, grass mowing, pruning.	1. **More accurate** and less likely to damage crops/fruit. 2. Potentially higher yields since seeding, fertiliser application and so on is more efficient; leads to **optimum conditions for growth and health**. 3. **Less labour needed** (for example, automatic weeding, fruit picking and so on). 4. **Plant health monitored better**, and problems can be identified earlier and rectified. 5. **Less waste** of seeds, fertilisers and so on.	1. Expensive systems to set up initially and to maintain. 2. Risk of cybercriminal activity (such as hacking, viruses and so on). 3. Risk of deskilling, since key farming skills could be lost (over-reliance on technology).
Medicine		
1. Surgical procedures. 2. Monitoring patients. 3. Disinfecting rooms and operating theatres. 4. Taking blood samples. 5. Micro bots used in target therapy. 6. Prosthetic limbs are minirobots.	1. Operations can be **quicker and safer** to carry out (fewer errors will be made). 2. Leaves doctors/surgeons available to **do more complex surgery** and leaves nurses to do more skilled work. 3. Taking blood samples is **less painful** to the patient; nurses and doctors are not subjected to potentially hazardous blood samples (for example, some viruses are very contagious). 4. Target therapy causes **less damage to surrounding tissues**. 5. Prosthetic limbs can now mimic human limb movement **more precisely**.	1. Robotic surgery is very **expensive to set up and maintain**. 2. **Difficult to make sure robots are fully disinfected** before doing surgical work. 3. **Risk of cybercriminal activity** (for example, hacking and viruses). 4. **Reluctance by the general population** to robotic surgery. 5. The all-important **human factor is missing**.
Domestic robots		
1. Autonomous vacuum cleaners. 2. Autonomous grass cutters. 3. Personal assistants.	1. Leave people **free to do other** (more interesting) tasks. 2. **More than one** task can be completed at the same time. 3. Can be programmed to **work at a specific time** of the day. 4. Can be **operated remotely** (for example, using mobile phone app). 5. Can automatically empty the dust bag/grass bag and **automatically park** and connect to the mains supply to recharge internal batteries. 6. Allow **linking together of several devices** in the home and can also carry out certain useful tasks (for example, get flight information or weather forecasts for the next day). 7. Can be programmed to **turn on lights at random times** at night if a house is unoccupied thus helping with security (there are many such tasks).	1. **Expensive devices to buy** initially and require regular expert servicing (sensors and cameras need specialist technicians). 2. Unable to deal with **unusual circumstances** as well as a human (for example, a tree has fallen on the grass). 3. **Battery life can be short**. 4. Sometimes **can't reach into corners** where dust/long grass accumulates and requires human action. 5. **Takes much longer** to do the tasks (up to three times longer than doing hoovering or grass cutting manually). 6. Personal assistants could **make people lazy** rather than looking up for information themselves. 7. Personal assistants can be **annoying** if used frequently. 8. Digital assistants can be **hacked into remotely**; this can result in a breach of the user's privacy. 9. Digital assistants can **collect and process user's personal data** without their knowledge.
Entertainment		
1. Theme parks and arenas/ large venues (robotic characters are used to interact with visitors). 2. Film and TV industry (operate cameras, stunt actions, special effects).	1. Greater realism to theme park characters, **increasing entertainment factor**. 2. Music festivals can be **more immersive** (robot-controlled lighting and animation); effects can be synchronised with music. 3. **Control of cameras leads to better results** (smoother action and always correctly focused). 4. **Better and more realistic animation** and more effective cross-over with animation and actual actors.	1. **Very expensive system to set up** initially and to maintain. 2. **Risk of deskilling** since many of the tasks done by skilled humans are now done by robots (for example, camera work).

IGCSE 06 Automated and emerging technologies(2)

Automated systems

An automated system is a **combination of hardware and software** that is designed and programmed to **work automatically without the need for any human** intervention.

Advantage and disadvantage of automated systems

Advantages of automated systems	Disadvantages of automated systems
1. Faster than humans taking any necessary action. 2. Safer if automated system is part of a hazardous system. 3. System is more likely to run under optimum conditions. 4. Less expensive in the long run/more energy efficient. 5. Can be a more effective use of materials and resources.	1. Often expensive to set up and purchase initially. 2. There is always the possibility for a set of conditions to occur which weren't considered during the development stage. 3. The constant fear of cyberattacks (hacking, viruses, and so on). 4. Automated systems need enhanced maintenance to operate correctly; this

Robotics

Robotics is a branch of (computer) science that **brings together the design, construction and operation of robots**.

Factories robots uses:

1. welding metal parts in a factory (car body panels)
2. spray painting panels
3. laser cutting of patterns (for example, in metal, plastic, leather) with a high precision and very little waste
4. bottling and canning in the food and drinks industry
5.warehouse logistics (for example, location of items and loading onto correct lorry).

Home robots uses:

1. autonomous **floor sweepers**
2. autonomous **lawn mowers**
3. automatic **window cleaning**
4. in **home entertainment** ('friend' robots).

Drones robots uses:

1. **reconnaissance** (for example, aerial photography)
2. **parcel deliveries** (particularly in busy cities)
3. **flying in dangerous areas** where there is a danger to human life (for example, carrying out a survey following a hazardous chemical spillage or nuclear incident).

Characteristics of a robot

1. **a mechanical structure or framework**
    1. Use sensors and cameras as input to the robot.
    2. Use sensors to recognise the immediate environment by building up a 3D picture to determine the size, shape and weight of an object, for example.
    3. All sensor data is sent to a microprocessor or computer.
2. **electrical components**, such as sensors, microprocessors and actuators
    1. Use of wheels, cogs, pistons, gears and so on, to carry out functions such as turning, twisting, moving backwards/forwards and gripping or lifting.
    2. Mechanical structures made up of motors, hydraulic pipes, actuators and circuit boards.
    3. Contain many electrical components.
    4. Able to use end-effectors – different attachments to carry out a number of tasks.
3. **programmable**
    1. Have a controller that determines the actions that need to be taken to carry out a task automatically.
    2. Controllers are programmable so that the robot can be 'trained' to do various tasks.

Artificial Intelligence(AI)

Artificial intelligence (AI) is a branch of computer science dealing with the simulation of intelligent human behaviour by a computer.

Three categories of AI

1. **Narrow AI**: a machine has superior performance to a human in one specific task.
2. **General AI**: a machine is similar, but not superior, in its performance in doing one specific task.
3. **Strong AI**: a machine has superior performance to humans in many tasks.

Examples of AI include:

1. news generation based on live news feeds
2. smart home devices/assistants (such as Amazon Alexa or Apple Siri)
3. use of chatbots that interact through instant messaging
4. autonomous vehicles
5. facial expression recognition.

Expert System:

Expert systems are a form of AI developed to **mimic human knowledge and experience**. They use knowledge and inference to solve problems by analysing responses to a series of questions thus mimicking a human expert.

Expert systems have **a knowledge base**, **a rule base**, **an inference engine** and **an interface**

Setting up an expert system

1. Information needs to be gathered from human experts or from written sources such as textbooks, research papers or the internet.
2. Information gathered is used to populate the knowledge base which needs to be first created.
3. A rules base needs to be created; this is made up of a series of inference rules so that the inference engine can draw conclusions.
4. The inference engine itself needs to be set up; it is a complex system since it is the main processing element making reasoned conclusions from data in the knowledge base.
5. The user interface needs to be developed to allow user and expert system to communicate.
6. Once the system is set up, it needs to be fully tested; this is done by running the system with known outcomes so that results can be compared and any changes to the expert system made.

Machine learning

Machine learning is a subset of AI where algorithms are **'trained' and learn from their past experiences**.

Machine learning is when a program has the ability to **automatically adapt its own processes and/or data**

IGCSE 07 Algorithm design and problem solving (1)

Program development life cycle

Stage:

Analysis: Process of investigation, using abstraction and decomposition to specify what a program does.

Design: Uses structure charts, flowcharts and pseudocode with the program specification from analysis to show to how the program should be developed.

Coding: Writing and iterative testing of the program or suite of programs.

Testing: Testing the completed program to make sure that it works under all conditions.

Maintenance

Computer system

Each **computer system** is made up of software, data, hardware, communications and people.

Each computer system can be divided up into a set of **sub-systems** and each sub-system can be **further divided into subsystems** and so on until each sub-system just performs a single action.

The process of **decomposition** into sub-systems so that a system can be more easily represented and understood is the basis of **top-down design**.

how a problem can be decomposed into its component parts

Any problem that uses a computer system for its solution needs to be decomposed into its component parts. These are **inputs**, **processes**, **outputs** and **storage**.

methods used to design and construct a solution:

1. structure diagrams
2. flowcharts
3. pseudocode.

Structure diagrams

structure diagram shows hierarchically how each computer system can be divided up into a set of sub-systems

Flowcharts

flowchart shows diagrammatically the steps required to complete a task and the order that they are to be performed. These steps, together with the order, are called an algorithm.

Flowcharts

Use	Symbol	Description
Terminator Start/Stop	START STOP	Used at the beginning and end of each flowchart. At least two outputs.
Process	A ← 0 B ← 0	Used to show actions, for example, when values are assigned to variables.
Input/Output	INPUT X	The same flowchart symbol is used to show the input of data and output of information.
Decision	x > B?	Used to decide which action is to be taken next. These can be used for selection and repetition/iteration. There are always two outputs from a decision flowchart symbol.
Flow lines	→	Used to show the direction of flow.

Standard methods of solution:

Totalling:

```
Total ← 0
FOR Count ← 1 TO ClassSize
   INPUT Mark
   Total ← Total + Mark
NEXT Count
```

Counting:

```
PassCount ← 0
FOR Counter ← 1 TO ClassSize
   INPUT Mark
   IF Mark > 50
      THEN
         PassCount ← PassCount + 1
   ENDIF
NEXT Counter
```

Finding maximum, minimum, average

```
Total ← 0
MaxMark ← 0
MinMark ← 100
FOR Count ← 1 TO ClassSize
   INPUT Mark
   IF Mark > MaxMark
      THEN
         MaxMark ← Mark
   ENDIF
   IF Mark < MinMark
      THEN
         MinMark ← Mark
   ENDIF
   Total ← Total + Mark
NEXT Count
Average ← Total / ClassSize
```

Pseudocode

Mathematical operators

Mathematical operators

Use	Symbol
+	Add
-	Substract
*	Mlutiply
/	Divide
^	Raise to the power
()	Group

Comparison operators

Operator	Comparison
>	Add
<	Substract
=	Mlutiply
>=	Divide
<=	Raise to the power
<>	Group
AND	Both
OR	Either
NOT	not

Pseudocode statement

Pseudocode statment	Examples
Assignment A value is assigned to an item/variable using the ← operator.	Cost ← 10 SellingPrice ← Price + Tax

Conditional 1
A condition that can be true or false: IF … THEN … ENDIF or IF … THEN … ELSE … ENDIF
For an IF condition the THEN path is followed if the condition is true, and the ELSE path if it is false (an ELSE may not be required). The end of the statement is followed by ENDIF
	IF Age < 18
	  THEN
	  OUTPUT "Child"
	  ELSE
	  OUTPUT "Adult"
	ENDIF

Conditional 2
A choice between several different values: CASE OF … OTHERWISE … ENDCASE
 	
For a CASE statement, the value of the variable decides the path taken. Several variables are usually specified.
OTHERWISE path is taken for all other values. The statement is ended by ENDCASE
	CASE OF Grade
	  "A" : OUTPUT "Excellent"
	  "B" : OUTPUT "Good"
	  "C" : OUTPUT "Average"
	  OTHERWISE OUTPUT "Improve"
	ENDCASE

Iteration 1 FOR … TO … NEXT a variable is set up, with a start value and an end value, this variable is incremented in steps until the end value is reached and the iteration finishes.	FOR Counter ← 1 to 10 OUTPUT "*" NEXT Counter

Iteration 2
REPEAT … UNTIL is used when the number of repetitions/ iterations is not known, and the actions are repeated UNTIL a given condition becomes true. The actions in this loop are always completed at least once.
	Counter ← 0
	REPEAT
	  OUTPUT "*"
	  Counter ← Counter + 1
	UNTIL Counter >= 10

Input INPUT used for data entry.	INPUT Name INPUT StudentMark
Output OUTPUT or PRINT used to display information.	PRINT "Your name is", Name OUTPUT Name1, "Ali", Name3

Nesting 1 Nested IF makes use of two IF statements; the second IF statement is part of the first ELSE or THEN path	IF Age < 18
	  THEN
	  OUTPUT "Child"
	  ELSE
	  IF Age > 65
	  THEN
	  OUTPUT "Senior"
	  ELSE
	  OUTPUT "Adult"
	  ENDIF
	ENDIF

Nesting 2 Nested iteration makes use of two loops; the second loop is inside the first loop.	FOR Number ← 1 to 10
	  OUTPUT Number
	  FOR Counter ← 1 to Number
	  OUTPUT "*"
	  NEXT Counter
	NEXT Number

Linear Search

```
OUTPUT "Enter name to find "
INPUT Name
Found ← FALSE
Counter ← 1
REPEAT
   IF Name = Name[Counter]
      THEN
         Found ← TRUE
      ELSE
         Counter ← Counter + 1
   ENDIF
UNTIL Found OR Counter > ClassSize
IF Found
   THEN
      OUTPUT Name, " found"
   ELSE
      OUTPUT Name, " not found."
ENDIF
```

Bubble sort

```
First ← 1
Last ← ClassSize
REPEAT
   Swap ← FALSE
   FOR Index ← First TO Last - 1
      IF Name[Index] > Name[Index + 1]
         THEN
            Temp ← Name[Index]
            Name[Index] ← Name[Index + 1]
            Name[Index + 1] ← Temp
            Swap ← TRUE
      ENDIF
   NEXT Index
   Last ← Last -1
UNTIL (NOT Swap) OR Last = 1
```

IGCSE 07 Algorithm design and problem solving (2)

Validation and verification

Data entry

Verification	Validation

Double entry	Screen.visual check	Range check	Length check	Type check	Presence check	Format check
The data is entered twice and compared to ensure both entries are the same	A manual check to ensure the data on the screen is the same as the form	Checks that the value of a number is between an **upper value** and a **lower value**	Checks that the data entered is a **reasonable number** or an **exact number** of characters	Checks that the data entered is of a **given data type**	Checks to ensure that some data has been entered and the value has **not been left blank**	Checks that the characters entered conform to a **pre-defined pattern**

Test data

Test data

Normal	Abnormal/ erroneous	Noundary	Extreme
Test data that is **accepted** and the algorithm is expected to work with	Test data that is **rejected** by the algorithm as not suitable	At each boundary two values are required; **one value is accepted** and **the other value is rejected**	The **largest and smallest values** that **normal data** can take

Trace table

A trace table records the results from **each step in an algorithm**;
it shows the value of **each variable every time that it changes**.
Working through an algorithm step by step is called a **dry run**.
A trace table is set up with a column for each variable and a column for any output.

Writing and amending algorithms

1. Make sure that the **problem is clearly specified** – the purpose of the algorithm and the tasks to be completed by the algorithm.
2. Break the problem **down in to sub-problems**. If it is complex, you may want to consider writing an algorithm for each sub-problem. Most problems, even the simplest ones can be divided into:
   - set-up processes
   - permanent storage of data
   - input (if required)
   - processing of data
   - output of results.
3. Decide on **how any data is to be obtained and stored**, what is going to happen to the data and how any results are going to be displayed.
4. Design the structure of your algorithm using a **structure diagram**.
5. Decide on how you are going to construct your algorithm, either using a **flowchart** or **pseudocode**. If you are told how to construct your algorithm, then follow the guidance.
6. Construct your algorithm, making sure that it can be easily read and understood by someone else. Precision is required when writing algorithms, just as it is when writing program code. This involves setting it out clearly and using meaningful names for any data stores.
7. Use several sets of **test data** (normal, abnormal and boundary) to **dry run** your algorithm and show the results in trace tables, to enable you to find any errors.
8. If any **errors** are found, correct them and repeat the process until you think that your algorithm works perfectly.

AND Gate:

logic notation
$$X = A \ AND \ B $$
boolean algebra
$$X = A.B $$

Input	Input	Outpu
A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

OR Gate:

logic notation
$$X = A\ OR\ B $$
boolean algebra
$$X = A\ +\ B $$

Input	Input	Outpu
A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

NAND Gate:

logic notation
$$X = A\ NAND\ B $$
boolean algebra
$$X = \overline{A\ .\ B} $$

Input	Input	Outpu
A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

NOR Gate:

logic notation
$$X = A\ NOR\ B $$
boolean algebra
$$X = \overline{A\ +\ B} $$

Input	Input	Outpu
A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

NOT Gate:

logic notation:
$$X = NOT \ A $$
boolean algebra
$$X = NOT \ \overline{A} $$

Input	Outpu
A	X
0	1
1	0

XOR Gate:

logic notation
$$X = A\ XOR\ B $$
boolean algebra
$$X = (A\ .\ \overline{B}\ ) + (\overline{A}\ .\ B) $$
$$X = \overline{(A\ .\ B) + (\overline{A}\ .\ \overline{B})} $$

Input	Input	Outpu
A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

IGCSE 08 Programming(1)

Comparison operators

Concept	Pseudocode	Python
Variable	DECLARE FirstVar: Integer	firstVar = 30
Constant	CONSTANT FirstConst = 500	FIRSTCONST = 500
Basic Type	1. Integer – a positive or negative whole number that can be used with mathematical operators. 2. Real – a positive or negative number with a fractional part; real numbers can be used with mathematical operators. 3. Char – a variable or constant that is a single character. 4. String – a variable or constant that is several characters in length. 5. Boolean – a variable or constant that can have only two values, TRUE	1. int 2. float 3. bool 4. str 5. bytes
Basic Type code	DECLARE FirstInt : INTEGER DECLARE FirstReal : REAL DECLARE Female : CHAR DECLARE FirstName : STRING DECLARE Flage : BOOLEAN	FirstInt = 25 FirstReal = 25.0 Female = 'F' FirstName = 'Emma' Flag = True
Input/Output	OUTPUT "Enter a whole number " INPUT FirstInt OUTPUT "Number is " FirstInt	FirstInt = int(input ("Enter a whole number")) Print ("Number is ", FirstInt)
sequence	The ordering of the steps in an algorithm.	The ordering of the steps in an algorithm.

Selection	IF Age > 17
	  THEN
	  OUTPUT "You are an adult"
	  ELSE
	  OUTPUT "You are a child"
	ENDIF
		if Age > 17:
		  print "You are an adult"
		else:
		  print "You are a child"

CASE statement	CASE OF OpValue
	  "+" : Answer = Number1 + Number2
	  "-" : Answer = Number1 - Number2
	  "*" : Answer = Number1 * Number2
	  "/" : Answer = Number1 / Number2
	  OTHERWISE OUTPUT "invalid operator"
	ENDCASE
		if OpValue == "+":
		  Answer = Number1 + Number2
		elif OpValue == "-":
		  Answer = Number1 - Number2
		elif OpValue == "*":
		  Answer = Number1 * Number2
		elif OpValue == "/":
		  Answer = Number1 / Number2
		else: print("invalid operator")

Iteration for statement	FOR Counter ← 1 TO 10 STEP 2
	  OUTPUT Counter
	NEXT Counter
		for Counter in range (1,10,2):
		  print(Counter)

Iteration pre-condition	WHILE TotalWeight < 100
	  TotalWeight = TotalWeight + Weight
	ENDWHILE
		while TotalWeight < 100:
		  TotalWeight = TotalWeight + Weight

Iteration post-condition	REPEAT NumberOfItems = NumberOfItems + 1 UNTIL NumberOfItems > 19	
totalling and counting	TotalWeight = TotalWeight + Weight NumberOfItems = NumberOfItems + 1	TotalWeight = TotalWeight + Weight NumberOfItems = NumberOfItems + 1
String-LENGTH	LENGTH("Computer Science") LENGTH(MyString)	len("Computer Science") len(MyString)
String-SUBSTRING	SUBSTRING("Computer Science", 10, 7) First parameter is the string second parameter is the position of the start character third parameter is the length of the required substring. SUBSTRING(MyString, 10, 7)	"Computer Science"[9:16] MyString[9:16]
String-UPPER	UCASE("Computer Science") UCASE(MyString)	"Computer Science".upper() MyString.upper()
String-LOWER	LCASE("Computer Science") LCASE(MyString)	"Computer Science".lower() MyString.lower()

IGCSE 08 Programming(2)

Comparison operators

Concept	Pseudocode	Python
add	+	+
Subtract	-	-
Multiply	*	*
Divide	/	/
Raise to the power of	^	**
Group	()	()
Reminder division	MOD	%
Greater than	>	>
Less than	<	<
Equal	=	=
Greater than or equal	>=	>=
Less than or equal	<=	<=
Not equal	<>	!=
Both True	AND	and
Either True	OR	or
Not True	NOT	not

Procedure stars - definition	PROCEDURE Stars
	  OUTPUT "*********"
	ENDPROCEDURE
		def Stars():
		  print("**********")

Procedure Stars with parameter – definition	PROCEDURE Stars (Number:INTEGER)
	  DECLARE Counter : INTEGER
	  FOR Counter ← 1 TO Number
	  OUTPUT "*"
	  NEXT
	ENDPROCEDURE
		def Stars(Number):
		  for counter in range (Number):
		  print("*", end = '')

Function with a parameter and return	FUNCTION Celsius(Temperature: REAL) RETURNS REAL
	  RETURN (Temperature – 32) / 1.8
	ENDFUNCTION
		def Celsius(Temperature):
		  return (Temperature - 32) / 1.8

MOD, DIV, ROUND and RANDOM	Value1 ← MOD(10, 3) Value2 ← DIV(10, 3) Value3 ← ROUND(6.97354, 2) Value4 ← RANDOM()	Value1 = 10%3 Value2 = 10//3 Value = divmod(10,3) Value3 = round(6.97354, 2) from random import random Value4 = random()
comments	// pseudocode uses a double slash to start a comment	#Python uses hash to start a comment for every line

Arrays

```
DECLARE MyTable : ARRAY[0:9,0:2] OF INTEGER
OUTPUT “Enter these values in order”
OUTPUT “27, 19, 36, 42, 16, 89, 21, 16, 55, 34”
OUTPUT “31, 67, 98, 22, 35, 46, 71, 23, 11, 76”
OUTPUT “17, 48, 29, 95, 61, 47, 28, 13, 77, 21”
FOR ColumnIndex ← 0 TO 2
    FOR RowIndex ← 0 TO 9
        OUTPUT “Enter next value “
        INPUT MyTable[RowIndex, ColumnIndex]
    NEXT RowIndex
NEXT ColumnIndex
```

Files

```
DECLARE TextLine : STRING   // variables are declared as normal
DECLARE MyFile : STRING
MyFile ← "MyText.txt"

// writing the line of text to the file
opens file for writing //OPEN MyFile FOR WRITE
    OUTPUT "Please enter a line of text"
    INPUT TextLine
    WRITEFILE, TextLine // writes a line of text to the file
CLOSEFILE(MyFile) // closes the file

// reading the line of text from the file
OUTPUT "The file contains this line of text:"
OPEN MyFile FOR READ // opens file for reading
    READFILE, TextLine // reads a line of text from the file
    OUTPUT TextLine
CLOSEFILE(MyFile) // closes the file
```

IGCSE 09 Database

Database
A database is a structured collection of data that allows people to extract information in a way that meets their needs. Data can include text, numbers and pictures.
A single-table database contains only one table.
A table consists of many records.
each **record** is a **row** in the table
each **field** is a **column** in the table.

Primary keys
The primary key is a field that **uniquely** identifies the record. Each primary key contains a **unique value**; it must contain data values that are never repeated in the table.

Mathematical operators

Data type	Description	Access data type
Text/alphanumeric	A number of characters	Short text/long text
Character	A single character	Short text with a field size of one
Boolean	One of two values: either True or False, 1 or 0, **Yes or No**	Yes/No
Integer	Whole number	Number formatted as fixed with zero decimal places
Real	A decimal number	Number formatted as decimal
Date/time	Date and/or time	Date/Time

Mathematical operators

SQL query statement	Description of statement
SELECT	Fetches specified fields (columns) from a table; queries always begin with SELECT
FROM	Identifies the table to use.
WHERE	Includes only records (rows) in a query that match a given condition.
ORDER BY	Sorts the results from a query by a given column either alphabetically or numerically.
SUM	Returns the sum of all the values in a field (column). Used with SELECT
COUNT	Counts the number of records (rows) where the field (column) matches a specified condition. Used with SELECT

Examples

SQL query statement	Description of statement
SELECT ItemDescription, Price FROM ItemsForSale WHERE Price > 10.00 ORDER BY Price;	Displays the description and price of all items for sale with a price of more than 10.00
SELECT SUM(Price) FROM ItemsForSale WHERE Price > 10.00	Displays the total value all items for sale with a price of more than 10.00
SELECT COUNT(Price) FROM ItemsForSale WHERE Price > 10.00	Displays the number of items for sale with a price of more than 10.00