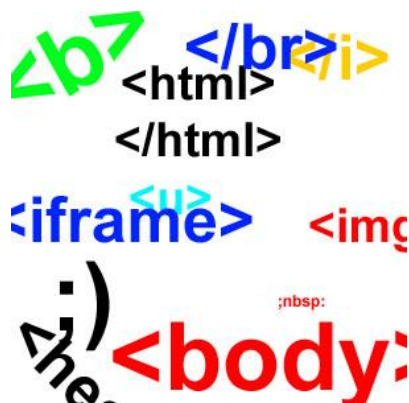


Computing Science

National 5

Summary Revision Notes



Contents

| | |
|---|----|
| Data Types and Structures | 3 |
| Expressions..... | 3 |
| Concatenation..... | 3 |
| Conditions | 3 |
| Iterative constructs | 3 |
| Selection Constructs | 3 |
| Standard Algorithm..... | 3 |
| Pre-Defined Functions..... | 4 |
| Testing..... | 4 |
| Errors..... | 4 |
| Readability | 4 |
| Planning..... | 4 |
| Data Representation | 4 |
| Calculation of graphic file size..... | 5 |
| Translators | 5 |
| Vector V's Bitmap..... | 6 |
| Basic Computer Architecture Diagram | 6 |
| Fetch Execute Cycle..... | 7 |
| Computer Hardware | 8 |
| Input Devices..... | 8 |
| Output Devices..... | 8 |
| Backing Storage..... | 8 |
| Cloud storage | 9 |
| Interfaces | 9 |
| CPU and Memory | 9 |
| Types of System | 9 |
| Networking..... | 10 |
| Software..... | 10 |
| The Internet | 10 |
| User Interface..... | 11 |
| File Types..... | 11 |
| Databases..... | 11 |
| Security | 12 |
| Legislation | 13 |
| Environmental Impact..... | 13 |

Programming

Data Types and Structures

We can use **variables** to store information when we are programming. Each **variable** stores one piece of information. We should state the **data type** of variables. The data types are: **Integer** for whole numbers; **Single** for decimal numbers; **String** for text and **Boolean** for true or false values.

Arrays work as numbered lists of variables. As well as declaring the data type we should also declare the size of the array. The location of each item in the array is tracked by using an index.

Expressions

We use **expressions** to work with variables. We can assign values to variables using the = operator. In visual basic we can set the value assigned (number=3) or allow the user to assign the value (number=textbox1.text or number=inputbox ("Enter a number"))

We can use arithmetic operations to work out problems. + adds numbers together, - subtracts one number from another, * multiplies numbers, / divides one number by another and ^ calculates powers of number (squares, cubes, etc.).

Concatenation

Concatenation uses the & symbol to join strings of text together. This is often used to display the value of a variable in a sentence during program output.

Conditions

We use mathematical comparators to create conditions. **Simple conditions** are <, <=, =, >= and >. **Complex conditions** are created by joining simple conditions together using the **logical operators AND, OR and NOT**.

Iterative constructs

There are two types of **iterative constructs**, **fixed loops (FOR...NEXT)** and **conditional loops (DO WHILE ... LOOP, and DO ... LOOP UNTIL)**. **Fixed loops** repeat a set number of times. **Conditional loops** repeat while or until a condition is met.

Selection Constructs

Selection constructs allow us to make decisions in a program. The most basic is **IF... THEN ... END IF**, this allows us to make a decision on 1 condition. IF statements can make complex decision by **nesting** them (putting IF statements inside other IF statements), or by using **IF ... THEN ... ELSEIF ... THEN ... ELSE ... END IF**. An alternative way of doing this is by using **SELECT CASE** to choose between different options.

Standard Algorithm

We need to know one **Standard Algorithm** for National 5. **Input Validation** is used to make sure that numbers entered into a program are within a certain range.

```
Do
    Number=inputbox ("Enter a number between 1 and 100")
    IF number<1 or number>100 then MsgBox ("Number must be between 1 and 100")
LOOP UNTIL number>=1 and number<=100
```

Pre-Defined Functions

Pre-Defined Functions are pieces of code built into our programming languages. We can use them to save time when we are programming because the testing and coding has already been done. Examples of predefined functions are **format (number, "currency")** to format a number as currency, **len (text)** to return the length of a piece of text and **randomize ()** to generate random numbers.

Testing

We need to test our programs using a combination of **Normal**, **Extreme** and **Exceptional** test data. **Normal** test data consists of everyday data that should normally be entered into a program. **Extreme** test data consists of data that is on the boundaries of being accepted by the program (if a program was to take in scores between 0 and 100 then 0 and 100 would be **extreme** test data). **Exceptional** test data consists of data that should not be accepted by the program (if a program was to take in scores between 0 and 100 then -1 and 101 would be **exceptional** test data)

Errors

There are 3 typical types of error. **Syntax Errors** are usually when a spelling mistake has been made. **Execution Errors** stop the program from running such as not declaring a variable. **Logic Errors** prevent the program from running properly (**LOOP UNTIL number<1 AND number>10** is a logic error because a number can never be less than 1 and more than 10) or assigning an incorrect message to a variable.

Readability

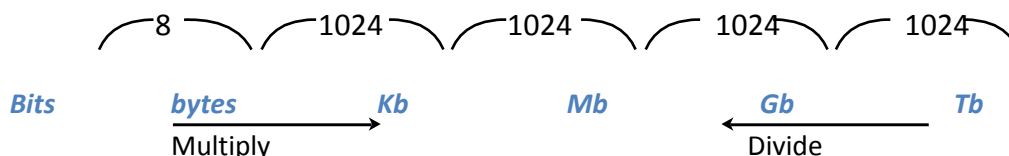
When we program we should make sure our code is easy to read. Using **meaningful variable names** will give a clearer indication of what your program should do. **Internal Commentary** (comment lines) can be used to describe what is happening in your program. **Indents** can be used to show parts of the program inside of constructs making the separate parts of your program clearer.

Planning

We should always plan our programs before we write them. There are 3 main ways of doing this. **Pseudocode** is often used to plan program. It uses a combination of programming constructs and English to create an easy to understand language that can be easily converted to lots of different programming languages. **Flow Charts** show the different parts of a program and how information flows between each part. **Structure Diagrams** use arrows and different shaped boxes to represent programming constructs in an easy to follow way.

Data Representation

Computers can only understand binary numbers (numbers made using only 1s and 0s). The smallest unit of measurement is 1 individual 0 or 1 called a bit. A collection of 8 bits is a byte. 1024 bytes is a kilobyte. 1024 kilobytes is a megabyte. 1024 megabytes is a gigabyte. 1024 gigabytes is a terabyte. We can change the units we use for storage by using the diagram below.



For the exam we will need to be able to change the decimal numbers we use to binary and back again.

| | | | | | | | |
|-----|----|----|----|---|---|---|---|
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| | | | | | | | |

This table can be used to convert numbers to and from binary. If we are changing binary number to decimal we write the binary number in the boxes on the bottom row of the table. If we add up the numbers at the top of the table which have 1 under them we will get the decimal number

| | | | | | | | |
|-----|----|----|----|---|---|---|-------|
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
| 128 | + | 32 | + | 8 | + | 2 | = 170 |

When changing a decimal number to binary we find the largest number on the top line that does not go over our decimal number and write a 1 under it. In this case we are converting 98. 64 is the largest without going over so we put a one under it. $98 - 64 = 34$. 32 is the biggest without going over 34 so we put a one under it. $34 - 32 = 2$ so we put a one under the 2. We put a 0 in every other box to get the answer

$$98 - 64 = 34 - 32 = 2 - 2 = 0$$

| | | | | | | | |
|-----|----|----|----|---|---|---|---|
| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 |

98=01100010

Decimal or **real** numbers are stored using a **mantissa** and an **exponent**. The larger the mantissa the more accurate the number will be. The larger the exponent the larger range of numbers that can be represented.

Graphics are stored as a grid of **pixels**. Each pixel is stored as a binary number recording the colour the pixel should be. The **resolution** of an image is the number of pixels across and down an image. You can work out the number of pixels used by multiplying the two parts of the resolution. Different numbers of bits are used to represent different colours; this is called **colour** or **bit depth**. The most common are: - Black and White - 1 bit, 256 colours – 8 bits, 65,536 colours – 16 bits, 16,777,216 colours – 24 bits.

Calculation of graphic file size

You will probably be asked to calculate the file size of an image. To do this, multiply the number of pixels by the bit depth e.g. Calculate the file size of a 256 colour image of resolution 600 x 400. 256 colours = 8 bits. $8 \times 600 \times 400 = 1,920,000$ bits. This will need to be expressed in appropriate units so $-1,920,000/8=240,000$ bytes $240,000 / 1024 = 234.375$ kilobytes. The higher the resolution and colour depth the more detailed our images will be but the file size will also increase. We can use compression to reduce file sizes. Lossy compression reduces file sizes the most but we end up lowering the quality of our images. Lossless compression doesn't reduce file sizes as much but we keep the same image quality.

Translators

Computer code is also represented in binary as **machine code**. This is different from the **high level languages** we use such as visual basic and scratch because it uses no English words to represent program constructs. This makes machine code too hard for us to use so we use translators to change our code into machine code. **Interpreters** translate code 1 line at a time as it is entered and processed. This is a slow process because code needs to be translated every time it is executed but it makes it easier to identify and fix errors. **Compilers** translate an entire program in one go. This is good because code does not need to be translated again so it will run quicker. However it does make it very difficult to find errors. Because of this we normally use **interpreters** when we create a program and **compilers** once our program is finished and tested.

Vector V's Bitmap

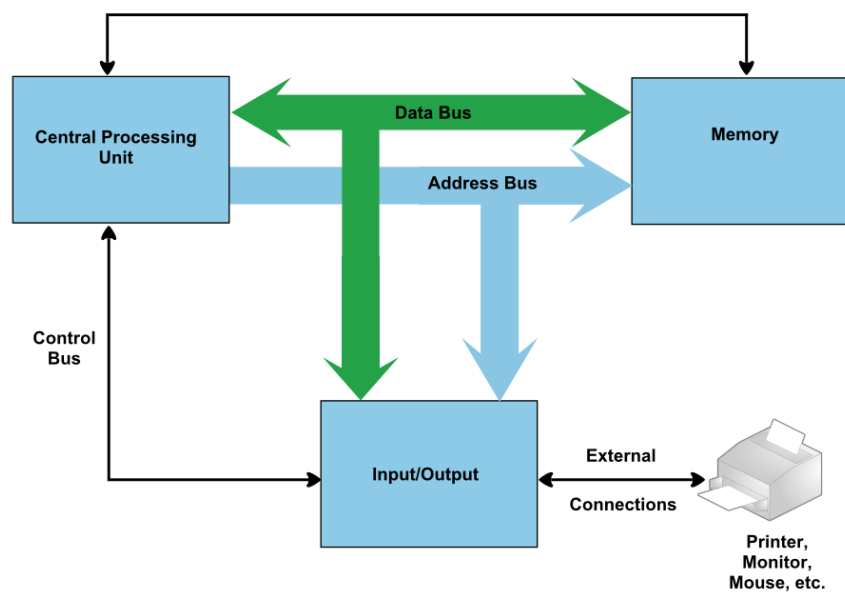
Advantages of vector graphics (draw packages)

- Images can be enlarged without losing resolution
- Objects can be edited by changing their attributes
- Objects can be layered on top/behind
- Images take up less disc space
- Ideal for drawing plans; use library of objects

Advantages of bit-mapped graphics (paint packages)

- Each pixel can be altered
- More realistic when used for photos/real life

Basic Computer Architecture Diagram



Fetch Execute Cycle

The basic operation of a computer is called the 'fetch-execute' cycle. The computer fetches the instruction from its memory and then executes it. This is done repeatedly from when the computer is booted up to when it is shut down.

Fetching the instruction

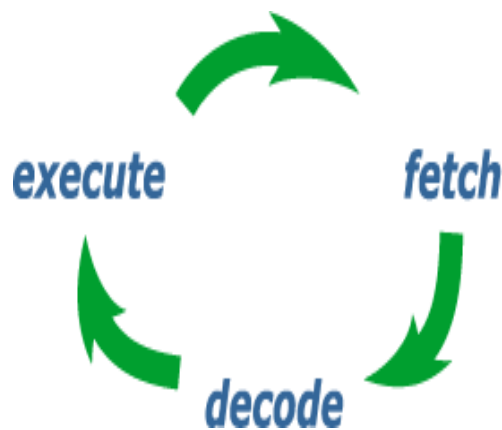
The first step the fetch-execute cycle carries out is fetching the instruction, which is either a program or data. The CPU fetches this from the main memory (the hard drive) and stores it in the CPU temporary memory (the registers).

Decoding

Once the instruction has been fetched, the CPU will need to understand the instruction to action it. This is called decoding.

Executing the instruction

When the instruction has been decoded, the CPU can carry out the action that is needed. This is called executing the instruction.



Computer Hardware

A computer system is composed of 4 main components: **Input Devices**, **Output Devices**, **Backing Storage** and the **CPU and Memory**.

Input Devices

Input devices are used to enter information into a computer system. The most common are keyboards, mice and touchscreens to enter instructions. Digital Cameras and scanners can enter images. Microphones can enter sounds and Digital Video cameras can enter videos.

Output Devices

Output devices are used to get information out of a computer system. The most common are monitors and projectors to display graphics, text and video. Speakers and headphones can output sounds. Laser and Inkjet printers can output paper copies of graphical and text information.

Backing Storage

There are different classes of backing storage based on how they store information and where they are used.

Internal devices are built into computer systems and are not easily removed. **External devices** can be unplugged for storage. **Portable devices** are small enough to carry around easily. **Magnetic storage** use magnetic disks to record information. **Optical storage** uses lasers to read information from and write information to reflective disks. **Solid State Storage** uses flash memory chips to record and retrieve information. The table below summarises the main types of storage and their categories

| Magnetic Storage | | |
|--|--|--|
| Internal | External | Portable |
| Internal Hard Disk High capacity Medium transfer rate | External Hard Disk High capacity Medium transfer rate | Floppy Disk Low capacity Low transfer rate |
| | Magnetic Tape High capacity Low transfer rate | |
| Optical Storage | | |
| Internal | External | Portable |
| Internal CD/DVD/Blu Ray drive Low to medium capacity Low to medium transfer rate | External CD/DVD/Blu Ray drive Low to medium capacity Low to medium transfer rate | CDs, DVDs, Blu Rays Low to medium capacity Low to medium transfer rate |
| Solid State Storage | | |
| Internal | External | Portable |
| Internal Solid State Drive (SSD) Medium Capacity Fast transfer rate | External Solid State Drive Medium Capacity Medium to Fast transfer rate | USB Flash Drive Low to medium Capacity Low to medium transfer rate |
| | | Flash memory cards Low to medium Capacity Low to medium transfer rate |

Solid state storage is the most rapidly advancing type of backing storage due to its light weight, its high transfer rates and its lack of moving parts which make it hard to break (**robust**).

Optical storage can also be classed as -ROM, -R or -RW. -ROM disks store data permanently and cannot be changed. -R disks are purchased blank and can have data written onto them once. -RW disks can be used to record data again and again.

Cloud storage

Cloud storage can also be used as backing storage. Cloud storage is saved on the Internet across multiple computer systems. Information stored on cloud storage can be accessed anywhere without needing to carry around any backing storage devices. It is protected using usernames and passwords so if you forget you will not be able to access your data. Cloud storage is very useful for phones and tablets that don't let you connect USB flash drives to them.

Interfaces

All computer components are connected using interfaces. Some, like HDMI, are specialised interfaces used for only one purpose. Others, like USB, are used to connect lots of different devices. USB comes in three different varieties USB1, USB2 and USB3. USB 1 has the slowest transfer speeds, USB 3 has the highest.

Functions of an interface are: - to connect a device/peripheral to the CPU, to compensate for differences in speed (processor higher speed than peripherals), for data conversion (analogue to digital, digital to analogue, differences in voltage) and for temporary storage (buffer).

CPU and Memory

The processor (CPU) controls the entire computer system. The memory holds information and programs that the computer is currently using. They are connected using: the **Address Bus**, which selects locations on memory; the **Data Bus**, which transfers information between the processor and memory; the **Control Lines** control the functions of the CPU and memory by saying which way information is flowing using the read and write lines and keeping the CPU and memory in synch using the clock line. We have 2 types of memory. **RAM** (Random Access Memory) is the computers main memory, it has fast access times but information is lost from it when the computer is turned off, this is why we save programs and data to backing storage. **ROM** (Read Only Memory) cannot be changed, it is used to hold the simple instructions that a computer needs to start its operating system. Inside the CPU we have: a **Control Unit**, which activates the **Control Lines**; **Registers**, which are temporary storage locations on the processor for instructions, memory locations and data; and the **Arithmetic and Logic Unit (ALU)**, which is responsible for calculations and decision making in the processor.

One way we can tell how fast a processor is to look at its **clock speed**. This is normally measured in gigahertz (GHz) and tells us how many billions of instructions are processed each second. Another measure is how many **cores** a processor has. Instead of increasing clock speed we can increase the number of cores in a processor. This will let the processor do more instructions at the same time. **Low power processors** are also being made for use in smartphones and tablets, they need to be low power so that batteries last a reasonable length of time.

Types of System

Different types of computer system have different uses. **Desktops** are the traditional computer systems and can be used for most purposes. **Laptops** have slightly less power than desktops but are portable to let people work in different locations. **Smartphones** and **tablets** are very portable but not as powerful as laptops they are useful but not as good for office working due to the lack of a keyboard. **Servers** have lots of network connections and are very powerful. They can be used to share files, host web sites and manage printing. **Supercomputers** are enormously powerful computers used by scientists to model weather systems and other theoretical models.

Networking

Computers can be connected together to share information, send messages or share expensive peripherals such as laser printers. A small network, about the size of a room or a building is called a local area network (**LAN**). We use a LAN to connect all the computers in our classroom. A large network covering a city, country or the world is called a wide area network (**WAN**). The most famous example of a WAN is the Internet.

Computers can be connected **wirelessly** through WiFi, Bluetooth or mobile phone signals. **WiFi** is the fastest but you need a wireless router to access it. **Mobile phone signals** are accessible almost everywhere but have data allowances and slower transfer speeds. **Bluetooth** is very slow and only works over a small area but uses very low amounts of electricity which makes it useful for mobile devices. Computers can also be connected by cables, **copper cables** are used for **Ethernet** (Local Area Network) and **phone lines** (Wide Area Network), **fibre optic** cables are also used for LANs and WANs. Fibre optic cables provide higher bandwidth but cost a lot more to implement.

There are two types of networks we need to know Peer to Peer and Client Server. **Peer to peer** networks are cheaper to use because you do not need expensive hubs or switches or a dedicated computer to use as a server, but they are less secure and it is hard to make backups because everyone has control over their own data. **Client Server** networks are more secure and are easier to back up but you have to buy additional equipment.

Software

Operating Systems are the main type of software that runs on a computer. In school we use Windows 7, but on your phones and tablets you may have iOS or Android. The operating system is responsible for saving and loading files, allocating memory and running programs. Modern Operating Systems are optimised for tablets and phones and will have large, easy to press buttons and gesture controls.

Browsers are used to display webpages. The browser requests a webpage and receives an HTML file which it uses to construct a web page out of the available text images and other media elements.

We also use Microsoft Access Database software and the Visual Studio and Scratch programming environments in school.

The Internet

Webpages are written in a mark-up or formatting language called HyperText Mark-up Language (**HTML**). HTML uses **formatting tags** to describe how information should be displayed. Additional features like animations or interactive menus can be added to webpages using a scripting language such as **JavaScript**. A **webpage** is an individual page of information on the internet. A **website** is a collection of related webpages. Webpages are identified by their Uniform Resource Locator (**URL**) or address. The URL for Google is <http://www.google.co.uk>. **Hyperlinks** are used to link webpages together. There are two type of hyperlink, internal and external. **Internal** hyperlinks send users to another page on the same website. **External** hyperlinks send users to another website. External hyperlinks use **absolute** addressing so they use a webpage's complete URL for the link. Internal hyperlinks can use absolute addressing but normally use **relative** addressing where they use only the part of the URL that is different from the current page.

User Interface

To make a website easy to use it should have a consistent design. This means that the layout of each page is roughly the same (the title and links etc. are all in the same place on each page). The layout of a website can be linear (you go through each page in order), hierarchical (you have a central menu that links to each page) or a combination of both. Your website should be easy to read and make good use of images and other types of media to explain the contents of each page. You should have different layouts for desktop and mobile viewers. Mobile users will not be able to use menus well and need larger links to click on. It is also a good idea to keep pages uncluttered as they will be hard to read on smaller screens. You should also take into account the accessibility of your website. This means that you have considered its use by people who may have additional support needs. Magnification features help short sighted users as does read out loud software. Hard of hearing users can be assisted by making sure that any videos used contain subtitles. You should also take into consideration the target audience of your website. How good is their computer knowledge beginner-expert? What age range young - elderly?

When you have finished your website you should test it to ensure that all of your links work and that all of the information is displayed properly and in the correct place.

Search engines use **Meta data** (information about webpages) to match up a user's search with webpages that have the information they require.

File Types

We can use **Standard File Formats** to save information so that anyone can access it. The standard file formats for text are: rtf and txt; audio are wav and mp3; graphics are jpg, bmp, gif and png; video are mp4 and avi. PDFs are a standard file format for multimedia and can hold text, graphics, audio and video.

Databases

A database is a system used to store, process and display information. Information is stored in **fields**, a field contains one piece of information. A collection of fields on an item is called a **record**. A collection of records is called a **file** or a **table**. Fields are set up to contain different types of information. The field types you should know are; text, number, date, time, graphic, object, calculated, link and Boolean. We can further ensure the accuracy of data by using validation checks. A **presence check** will make sure that information has been entered, **restricted choice** gives the user options from a menu to select, a **field length check** ensures that a minimum amount of information is entered and **range check** makes sure that data falls within a certain range. One field in every record should be a primary key, which is used as a unique identifier for that record. Databases can be modified by **inserting** new fields, records or tables, **deleting** fields, records or tables and by **updating** fields, records and tables.

Databases can either be stored as **linked tables**, joined together using **foreign keys** or **flat file**, where all information is stored in one table. Linked tables are more commonly used as using flat file databases can lead to data duplication and modification errors.

In the exam you may be asked to describe how a database has been sorted or how to search for information. To describe how a database has been **sorted** check the contents of each field along all the records. One of the fields will be in order alphabetically or numerically you need to write down this field and whether it is sorted in ascending or descending order. Some of the field values will be the same. Look for these values then check the other fields to see the second field that the database has been sorted on.

To describe how to **search** for information in a database say that you will search the database for
nameoffield1=value1 AND/OR nameoffield2=value2

Security

Malware is malicious programs designed to damage or intrude on a computer system. The three types of malware we need to know about are viruses, spyware and keyloggers. A **virus** is a program designed to cause damage to a computer system, it may be disguised as a legitimate program (Trojan horse) or it may find its own way onto a computer system (Worm). **Spyware** records a user's actions on their computer and transmit them to a hacker. **Keyloggers** record the key strokes entered on the computer and can be used to transmit usernames, passwords and bank details to a hacker as they are entered into the computer.

Phishing is using fake emails and/or websites that appear to be from a real company to trick users into entering their personal details. These details can be used to steal money from bank accounts or credit cards or to create false identities to run up debts in your name.

When disposing of old computing equipment it is very important to destroy the hard disks so that any sensitive information that was stored on them cannot be recovered.

Denial of Service attacks are when a server is disrupted by repeated requests from another computer. Ping requests are usually used to get the server to respond but when lots of ping request occur at once the server will not be able to handle them and the users of the server may find their service much slower or not available.

Antivirus software can be used to prevent and remove viruses. **Firewalls** can be used to stop hackers gaining access to your computer. A **security suite** combines an anti-virus and a firewall into one program and often has other features such as anti-spyware and anti-phishing.

Username and passwords can be used to make it harder for someone to access your data, but they can be guessed eventually. **Biometric** security is much more reliable as every person's body measurements are unique and hard to fake. The most common types of biometric security are fingerprint scanners and retina scanners.

Encryption is when information is put into code so it cannot be read. Websites encrypt usernames, passwords and card details to stop other people from seeing them. This makes sure that people are not scared to use their site for shopping.

Legislation

There are 5 laws we need to know.

1. The Data Protection Act

This is the law that protects personal data. Before anyone can use personal data they have to enter the Data Protection register. Personal data must be kept securely and protected. It must be kept up to date and accurate and should only be kept for as long as it is needed.

2. The Computer Misuse Act

This is the law that makes it illegal to hack into other computers and to create viruses.

3. The Copyright Designs and Patents Act

This is the law that makes it illegal to download copyrighted information from the Internet. It mostly covers Music and Films but also protects images and books.

4. The Communications Act

This makes it illegal to steal someone's WiFi, even if it is unsecured. It also stops companies having a monopoly over internet services to keep prices down.

5. The Health and Safety at Work Act

This law helps to ensure good working conditions. Employers must provide ergonomic workstations that are adjustable for users to reduce the risk Repetitive Strain Injury. Good quality lighting, eye test and adjustable monitors help to reduce eye strain. Work areas and offices should be uncluttered with no trailing wires or overloaded sockets to help prevent accidents.

Environmental Impact

Computers can benefit the environment by reducing the use of paper based systems which will reduce our carbon footprint. They can also reduce the need for air travel by use of video conferencing, this reduces the use of fossil fuels and our **carbon footprint** (the amount of carbon dioxide released into the atmosphere as a result of the activities of a particular individual, organization, or community).

Computers can be harmful to the environment because they require energy to manufacture and run, this could increase our carbon footprint if it comes from a coal or gas fired power station. Computers also make use of a lot of toxic chemicals in their construction. Old computer equipment should not be dumped with normal rubbish as the chemicals can leak out of landfills and pollute the environment.